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September 30, 1990

Energy Research Abstracts

Abstracts 40272–42320

Office of Scientific and Technical Information
UNITED STATES DEPARTMENT OF ENERGY

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Energy Research Abstracts

Purpose

Energy Research Abstracts (ERA) provides abstracting and indexing coverage of all scientific and technical reports, journal articles, conference papers and proceedings, books, patents, theses, and monographs originated by the U.S. Department of Energy, its laboratories, energy centers and contractors. *ERA* also covers other energy information prepared *in report form* by federal and state government organizations, foreign governments, and domestic and foreign universities and research organizations. Foreign information is obtained through the International Energy Agency's 14-nation Energy Technology Data Exchange, the International Atomic Energy Agency's International Nuclear Information System, or nation-to-nation agreements. **Please note that *ERA* coverage of nonreport literature is limited to that generated by Department of Energy activity.**

Scope

ERA is comprehensive in its subject scope, encompassing DOE's research, development, demonstration, and technological programs resulting from its broad charter for energy sources, supplies, safety, environmental impacts, and regulation.

The citations presented in *ERA* are available for online searching as records within the Energy Data Base. The current-year records are available on the Integrated Technical Information System (ITIS). The entire database is available through commercial online vendors.

Availability

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ERA is available to the public on a subscription basis from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402. The subscription rate for 24 semimonthly issues is $184.00 for domestic subscribers and $230.00 for foreign subscribers. A single issue costs $27.00, domestic, or $33.75, foreign. Cumulative indexes are available from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402. The GPO Stock Number is 061-000-00749-1 for the Volume 14 indexes.

Managing Editor, Audrey B. Smith
Technical Editor, Robert W. Rutkowski

Information Sources

The citations presented in *Energy Research Abstracts* are a subset of the worldwide energy information provided to the Office of Scientific and Technical Information (OSTI) through exchange agreements with foreign sources and through exchanges or contracts with U.S. organizations.

The **Energy Technology Data Exchange (ETDE)** was established by the International Energy Agency to promote cooperation among members in conducting appropriate energy-related research and development programs through the development of a formal central information sharing system. In accomplishing the objectives of the ETDE, members select, abstract, and index relevant research information published in their countries in accordance with Exchange standards. OSTI serves as the central receiving and processing center for this information, which it then disseminates to national centers in the participating countries. The following countries are currently members of the ETDE:

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United Kingdom
United States

The **International Nuclear Information System (INIS)** was established to promote the exchange of information on nuclear science and technology. Its operation is similar to that of the ETDE, with the INIS Secretariat being located in Vienna, Austria. Currently, 75 countries and 14 international organizations are members of INIS. OSTI serves as the INIS national center for the United States.

In the exercise of its rights and responsibilities under the agreements to which it is a party, the **Office of Scientific and Technical Information** both receives information from the above sources and submits U.S.-produced information to them. In addition to materials generated by the Department of Energy, this U.S.-produced information is gathered from other government agencies as well as under contract with private information processing companies. All input is computer processed and entered into a database for online retrieval. The database serves as well for the production of numerous OSTI publications.

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1. **Abstract number** within volume.
2. **Report number** identification for report-type literature.
3. **Title and subtitle** (non-English title may appear in parentheses, if applicable).
4. **Author(s).** First 10 names in the data record are printed, then "et al." is listed.
5. **Author affiliation.** Only first one is listed, in parentheses after author(s) to which it applies.
6. **Collaboration,** if present.
7. **Corporate author(s)** identifying corporation responsible for document.
8. **Patent assignee and number** for citations of patent documents or applications.
9. **Journal title, volume, and issue** for citations of journal articles.
10. **Date of publication.** If not known, a processing date is in brackets.
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14. **Publisher's name and location** for documents published by a corporate or commercial source.
15. **Sponsoring organization.**
16. **Contract or grant number.**
17. **Secondary identifying number;** may be a conference number.
18. **Conference title, location, and date,** if applicable.
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20. **Sources of availability** from which a copy of the document may be obtained; usually appear as abbreviations. (See information on following page.)
21. **Drop note** or explanatory statement.
22. **Abstract.**
23. **Subject descriptors.** Listed only if no abstract or only a brief statement is included.

Sample Citations

Report

18494 (DOE/ER/40438–T1) **[Development of a hydrogen and deuterium polarized gas target for application in storage rings]: Progress report.** Haeberli, W. Phys. VI collaboration. Wisconsin Univ., Madison (USA). Dept. of Physics. [1989]. 12p. Sponsored by DOE Energy Research. DOE Contract FG02-88ER40438. Order Number DE89007246. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This paper briefly discusses the Wisconsin test facility for storage cells; results of target tests; the new UHV...

Report Analytic

18500 (INIS-SU—69, pp. 30-32) **Transition energies in Ne-like ions. Correlation effects.** Vainshtejn, L.A. AN SSSR, Moscow. Fizicheskij Inst. 1988. (In Russian). In *Experimental and theoretical physics. Collection.* Order Number DE89780060. Available from NTIS (US Sales Only), PC A03/MF A01; INIS.

Kratkie Soobshcheniya po Fizike.; no. 6.

SILVER IONS/energy-level transitions; XENON IONS/energy-level transitions; CORRELATIONS; D STATES; E STATES;...

Journal Article

19055 **A theoretical and experimental investigation of long-pulse, electron-beam-produced rare gas plasmas.** Brake, M.L.; Repetti, T.E. (Energy Beam Interaction Lab. of the Dept. of Nuclear Engineering, Univ. of Michigan, Ann Arbor, MI (US)). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Plasma Science (USA),* 16(5): 581-589 (Oct 1988). (CONF-881020--: Symposium on radiation physics, Sao Paulo, Brazil, October 3, 1988).

Visible emission spectroscopy (380-650 nm) has been performed on intense, electron beam (1 kA, 300 ns, 300 kV) produced Ar, Kr,...

Patent

18045 **Polarization of fast particle beams by collisional pumping.** Stearns, J.W. To Dept. of Energy, Washington, DC. USA Patent 4,724,117. 9 Feb 1988. Filed date 19 Oct 1984. vp. Available from Patent and Trademark Office, Box 9, Washington, DC 20232.

A method for polarizing a fast beam of particles by collisional pumping, comprising the steps of generating a beam...

How To Order from the Availability Sources

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Report literature, usually identified by an alphanumeric identifier at the beginning of a citation, is available from the sources listed in the citation (see example of element 20 on page iii). Often the sources are listed as abbreviations. Corresponding addresses are provided at right from which documents with these abbreviations may be ordered. When "OSTI" is given, **DOE and DOE contractors may order these documents from OSTI.** (However, check with your library or information organization which may require that orders go through them to OSTI.) The public should order from NTIS or from one of the other agencies listed in the citation. To expedite processing, an order form is provided in the back of this publication. NOTE: The order numbers provide quicker access for report ordering. Use the order number where possible.

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INIS *Available only in microfiche.*
INIS Clearinghouse
International Atomic Energy Agency
P.O. Box 100, A-1400
Vienna, Austria

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Journal articles *Chemical Abstracts Service Source Index (CASSI)* tells which libraries, both U.S. and foreign, contain a journal and the available years. *Ulrich's International Periodicals Directory* contains information on the journal and its publisher. For librarians, another source of information is On-Line Computer Library Center (OCLC), for interlibrary loans.

Books, conferences, and monographs The source for these publications is the publisher or the originating society, organization, or institution. DOE-supported conferences and individual papers reporting DOE-supported research may be available as reports from OSTI.

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United Kingdom

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Five indexes are provided for approaching the content of each issue of *Energy Research Abstracts.* Descriptions of entries in these indexes follow.

Corporate Author Index
The corporation, organization, or institution responsible for the issuance of the document is listed in this index. The entries are arranged alphabetically and provide the title and citation number of the reference. For example, the listing for the "Report" sample citation would appear as shown at right.

Wisconsin Univ., Madison (USA). Dept. of Physics
[Development of a hydrogen and deuterium polarized gas target for application in storage rings]: Progress report, 15:18494 (R;US)
Wisconsin Univ., Madison (USA). Lab. of Genetics
Organization of the R chromosome region in maize: Final progress report, June 1, 1983–May 31, 1986, 15:18255 (R;US)

Personal Author Index
Each author's name listed on a document cited in this issue is indexed. An index entry provides title and citation number; for secondary and other names, a cross-reference is given to the primary author name where the full index entry is located.

Hadley, D.L., *See* Lee, A.D., 15:17651
Haeberli, W., [Development of a hydrogen and deuterium polarized gas target for application in storage rings]: Progress report, 15:18494 (R;US)

Subject Index
This index lists the main subject descriptors assigned to each record by indexing professionals. A secondary or qualifier term is used where necessary to describe materials, objects, and processes. Document titles may be enhanced with additional informative phrases where necessary. An excerpt from this index appears at right.

HYDROGEN ISOTOPES
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HYDROGEN 4
TRITIUM
Neutron-Rich Isotopes
Study on the strong neutron-rich nuclei of lightest elements, 15:18686 (RA;SU;In Russian)

Contract Number Index
DOE technical reports are listed by contract number. Each entry also provides the primary corporation or organization cited for that contract number. A typical entry is shown.

FG02-88ER40438 **Wisconsin Univ., Madison (USA). Dept. of Physics**
15:18494 DOE/ER/40438–T1
FG02-88ER60664 **Rogers and Associates Engineering Corp., Salt Lake City, UT (USA)**
15:17641 DOE/ER/60664–1

Report Number Index
Technical report literature is indexed by the alphanumerical identifier of the report. Patent documents and conferences are included for convenience. Each entry lists the citation number, the source of availability of the document, an indicator of presence at a GPO depository library, order number, and distribution category. A typical entry is:

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T1 15:18494 NTIS, PC A03/MF A01 - OSTI E 1.99: DE89007246 MF-411

Subject Contents

The subject content of *Energy Research Abstracts* is arranged as shown below. The two-digit and four-digit category numbers printed here illustrate the category number assignment used in the database records.* The following list includes all of the 39 first-level and the 308 second-level categories. Because each issue of *ERA* publishes citations only for those documents announced during the past semimonthly period, some subject categories may not be present in every issue.

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*The numerical subject category scheme is used in the storage, retrieval, and manipulation of bibliographic information entered into DOE's data systems. Categories and definitions for the complete set of six-digit numbers are given in DOE/TIC-4584, *Energy Data Base: Subject Categories and Scope*.

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Energy Research Abstracts

01 COAL, LIGNITE, AND PEAT

40272 (DOE/FE–0193P) **Clean coal technology: The new coal era.** USDOE Assistant Secretary for Fossil Energy, Washington, DC (USA). Jun 1990. 38p. Sponsored by U.S. DOE Fossil Energy. Available from OSTI (Free of Charge).

A brief overview is presented on coal, coal conversion, and the US clean coal technology program. (CBS)

0103 Preparation

Refer also to citation(s) 40338

40273 (CONF-900801–17) **Physical coal cleaning of Midwestern coals by open-gradient magnetic separation.** Doctor, R.D.; Livengood, C.D. Argonne National Lab., IL (USA). [1990]. 8p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract W-31109-ENG-38. From 25. intersociety energy conversion engineering conference; Reno, NV (USA); 12-17 Aug 1990. Order Number DE90013891. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Open-Gradient Magnetic Separation (OGMS) using superconducting quadrupole magnets offers a novel beneficiation technology for removing pyritic sulfur from pulverized dry coal. It is estimated to have a power demand 75% lower than techniques using conventional electromagnets, while achieving higher separation forces. Additionally, the system operates in a continuous mode and uses no chemicals. Because OGMS is specifically applicable to finely ground coal (120-325 mesh), its development could encourage the commercialization of other unconventional coal technologies, such as coal-water slurries, fluidized-bed combustion, and synfuels. 3 figs., 1 tab.

0104 Processing

Refer also to citation(s) 40318, 40325, 40339, 40348, 40590, 40594, 40595

40274 (CONF-900466–71) **Designing precipitation-strengthened iron-aluminides for high-temperature applications.** Maziasz, P.J.; McKamey, C.G.; Hubbard, C.R. Oak Ridge National Lab., TN (USA). [1990]. 11p. Sponsored by U.S. DOE Conservation & Renewable Energy; U.S. DOE Fossil Energy. DOE Contract AC05-84OR21400. From Spring meeting of the Materials Research Society; San Francisco, CA (USA); 16-21 Apr 1990. Order Number DE90013832. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

A combination of minor solutes was added to an Fe_3Al-type base alloy (Fe–28%Al–6%Cr–0.05%B) to produce carbide precipitates. These solutes reacted to produce coarse Ti-rich MC and Cr- and Mo-rich M_6C precipitates during fabrication at 650–1000°C. X-ray diffraction of hot-worked material revealed a significant amount of the higher-temperature B2 phase is retained at room temperature, indicating that the $D0_3 \leftrightarrow$ B2 phase transformation was retarded. During subsequent heat-treatments, the coarse carbides partially dissolved during annealing at 1100–1200°C, and no grain coarsening was observed at temperatures up to 1200°C. Specimens annealed for 1h at 1250°C and quenched exhibited fine carbide precipitates both along some of the dislocations and at grain boundaries. The annealed and quenched specimens also contained many fine dislocation loops which coarsened and evolved into networks during further aging at 750°C for 1–10h. Tensile testing at 600°C showed improvements in strength and ductility of annealed and aged material relative to the hot-worked condition. Correlation of microstructural behavior with tensile properties changes supports the idea that microstructural control can be used to develop better high-temperature strength in the B2 phase. However, more data is needed on the combinations of alloying and heat-treating which produce fine, stable matrix carbide dispersions in iron-aluminides. 12 refs., 3 figs., 1 tab.

40275 (CRIE-U–89042) **Bioprocessing of coal (2).: Application of bioprocessing to coal cleaning technique.** Omura, N.; Kimura, K.; Kono, Y.; Saiki, H. Central Research Inst. of Electric Power Industry, Abiko, Chiba (Japan). Dec 1989. 40p. (In Japanese). Order Number DE90507845. Available from NTIS (US Sales Only), PC A03/MF A01.

The authors surveyed current coal cleaning techniques and investigated an application of microbial coal cleaning to both of current coal fired power plants and newly developing power plants, such as coal water mixture (CWM) power plants or coal gasification combined cycle power plants. Coal cleaning techniques are classified into three areas, physical, chemical and microbial. Microbial coal cleaning may be capable to be applied as a technique before combustion to various types of coal fired power plants, for reduction of sulfur emission and ash output from power plants. Two kinds of microbial techniques, one is combined application to flotation in the CWM production process, and the other is heap leaching at coal storage sites. In order to establish microbial cleaning system, its related techniques such as acidic drain transaction system etc. must be developed simultaneously. 86 refs., 11 figs., 9 tabs.

40276 (CRIE-W–89014) **Development of gas turbine combustor burning coal derived low BTU gaseous fuels (part 4).: Low NOsub x combustion technology by rich-lean combustor with pilot flame.** Sato, M.; Ninomiya, T.; Nakada, T.; Abe, T.; Ishikawa, H.; Yoshine, T.; Yamada, M.; Hisa, S.; Hasegawa, H. Central Research Inst. of Electric Power Industry, Tokyo (Japan). Oct 1989. 25p. (In Japanese). Order Number DE90507871. Available from NTIS (US Sales Only), PC A03/MF A01.

This paper describes the development of gas turbine combustor burning coal derived low calorific value gaseous fuels. Combustion tests were conducted using a combustor of a 150MW class gas turbine. Coal derived gaseous fuels contain carbon monoxide and hydrogen as main combustible components, but also contain more than 60 percent of nitrogen, carbon dioxide etc., and their calorific values are approximately one-tenth of natural gas. Rich-lean combustion was very effective for decreasing fuel nitrogen oxides emission in a gas turbine combustor. However, the flame stability must be maintained in a primary combustion zone, and a sub combustor was provided for the flame stability. The combustibility of the tested combustor was excellent. Methane concentration in coal derived gaseous fuels affected on fuel nitrogen oxides formation, and it was clarified that there will be optimum equivalence ratio in a primary combustion zone according with the change of methane concentration. 22 refs., 19 figs., 1 tab.

40277 (DOE/MC/10637–2803) **Low-rank coal research: Quarterly report, October 1988–December 1988.** North Dakota Univ., Grand Forks, ND (USA). Energy and Mineral Research Center. [1989]. 513p. Sponsored by U.S. DOE Fossil Energy. DOE Contract FC21-86MC10637. Order Number DE90014270. Available from NTIS, PC A22/MF A01 - OSTI; GPO Dep.

Research programs on low rank coal are presented. Topics include: SO_x/NO_x Control, waste management, turbine combustion phenomena, combustion phenomena, combustion inorganic transformation, coal/char reactivity, liquefaction reactivity of low-rank coals, gasification ash and slag characterization, fine particulate emissions, fluidized bed combustion, beneficiation of low-rank coals, combustion characterization of low-rank coal fuels, diesel utilization of low-rank coals, low-rank coal direct liquefaction, hydrogen production from low-rank coals, advanced wastewater treatment, mild gasification, color and residual COD removal from synfuel-wastewaters, Great Plains Gasification Plant, and gasifier optimization. Individual projects are processed separately for the data bases.

40278 (DOE/MC/24167–2840-Vol.1) **Rawlins UCG [underground coal gasification] Demonstration Project site characterization report: Volume 1, Geological characterization.** Energy International, Inc., Pittsburgh, PA (USA). Apr 1989. 547p. Sponsored by U.S. DOE Fossil Energy. DOE Contract FC21-88MC24167. Order Number DE90009652. Available from NTIS, PC A23/MF A01 - OSTI.

The US Department of Energy and Energy International, Inc. have entered into a Cooperative Agreement to conduct a cost-shared UCG field test demonstrating the operation of commercial scale underground coal gasification (UCG) on steeply dipping bed modules to provide synthesis gas for a small scale commercial ammonia plant. The field test and the commercial ammonia plant will be located at the North Knobs site near Rawlins, Wyoming. During this demonstration test, two or more UCG modules will be operated simultaneously until one module is completely consumed and an additional module is brought on line. During this period, the average coal gasification rate will be between 500 and 1200 tons per day. A portion of the raw UCG product gas will be cleaned and converted into a synthesis gas, which will be used as feedstock to a 400–500 ton per day ammonia plant. The UCG facility will continue to operate subsequent to the test demonstration to provide feedstock for the commercial plant. The objective of the geologic site characterization program is to provide a descriptive model that accurately represents the geologic environment of the coal resource that is to be gasified. This model is to be used as an aid in understanding the hydrology of the coal bearing sequence, as a framework for installation of the process wells and the subsequent exploitation of the coal resources. 3 figs., 3 tabs.

40279 (DOE/MC/24167–2840-Vol.2) **Rawlins UCG [underground coal gasification] Demonstration Project site characterization report: Volume 2, Hydrological characterization.** Energy International, Inc., Pittsburgh, PA (USA). Apr 1989. 129p. Sponsored by U.S. DOE Fossil Energy. DOE Contract FC21-88MC24167. Order Number DE90009653. Available from NTIS, PC A07/MF A01 - OSTI.

The United States Department of Energy and Energy International, Inc. have entered into a Cooperative Agreement to conduct a cost-shared UCG field test demonstrating the operation of commercial scale Underground Coal Gasification (UCG) on steeply dipping bed modules to provide synthesis gas for a small scale commercial ammonia plant. The field test and the commercial ammonia plant will be located at the North Knobs site near Rawlins, Wyoming. During this demonstration test, two or more UCG modules will be operated simultaneously until one module is completely consumed and an additional module is brought on line. During this period, the average coal gasification rate will be between 500 and 1200 tons per day. A portion of the raw UCG product gas will be cleaned and converted into a synthesis gas, which will be used as feedstock to a 400–500 ton per day ammonia plant. The UCG facility will continue to operate subsequent to the test demonstration to provide feedstock for the commercial plant. The objective of the hydrologic site characterization program is to provide an accurate representation of the hydrologic environment within the area to be gasified. This information will aid in the placement and operation of the process wells in relation to the ground water source. 21 refs., 14 figs., 6 tabs.

40280 (DOE/MC/24207–2826) **Implementation of a modified Johnson and Hindmarsh mass and energy model: Final report.** Trapp, G. West Virginia Univ., Morgantown, WV (USA). Dept. of Statistics and Computer Science. Apr 1990. 15p. Sponsored by U.S. DOE Fossil Energy. DOE Contract FC21-87MC24207. Order Number DE90000488. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The primary purpose of this research work was to provide METC with computer software to simulate various fossil fuel process configurations. In particular, software to simulate mass and energy transfer for various fossil fuel reactions was required. To these ends the code MSRS was installed and tested at METC and then enhanced into an engineering modeling code useable by METC scientists and engineers. The enhancements consisted of adding reaction capabilities which grew out of XELAMP, improved input capabilities which made the code easier to use, and increased output media such as graphics. The input and output capabilities were patterned after the XELAMP system. Validation and consistency of the work can be checked using the LFER code; output from LFER can be input to MSRS and the corresponding temperatures can be compared. 3 refs., 1 fig.

40281 (DOE/MC/24207–2850) **A knowledge-based system for fluidization studies: Annual report.** West Virginia Univ., Morgantown, WV (USA). Dept. of Statistics and Computer Science. Apr 1990. 40p. Sponsored by U.S. DOE Fossil Energy. DOE Contract FC21-87MC24207. Order Number DE90009661. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Chemical engineers depend on process simulation models to determine "optimal" plant configurations which are technically feasible and economically viable. This research was undertaken to develop a comprehensive knowledge based simulation environment IPSE (Intelligent Process Simulation Environment) that can enhance the productivity of chemical engineers/modelers by serving as an intelligent assistant during all phases of process simulation involving fossil energy processes. In summary, the goals of this research are: application of knowledge-based techniques to the process modeling domain for enhancement of productivity; archiving and distribution of the knowledge of the best experts of process modeling; cross-model inference assistance to modelers not familiar with the process; and development of IPSE to serve as an intelligent tutoring system for process simulation. 18 figs.

40282 (DOE/PC/60808–T1) **Evaluation of intermolecular attractive forces in coal-derived liquids: Final report, August 1983–July 1987.** Jones, M.B. North Dakota Univ., Grand Forks, ND (USA). Dept. of Chemistry. Aug 1989. 47p. Sponsored by U.S. DOE Fossil Energy. DOE Contract FG22-83PC60808. Order Number DE90013397. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The effect of structural features (hence types of intermolecular interactions) on the physical properties of coal-derived preasphaltenes was studied by comparing (1) the solubility of several model compounds of known structure with the dissolvability of preasphaltene samples as a function of solvent parameters and (2) intrinsic viscosities of model compounds of known structure with viscosities of preasphaltene samples. The quantitative dissolvabilities of nine model compounds and nine preasphaltene samples isolated from different liquefaction runs in 12 solvents were measured. The dissolvabilities were correlated with five solvent parameters: Hildebrand solubility parameter (δ), net hydrogen-bonding index (θ), donor number (DN), donor number minus acceptor number (DN-AN), and donor number divided by acceptor number (DN/AN). The intrinsic viscosities of 66 model compounds and 38 size-separated preasphaltene samples were determined in THF solution. The model compounds were divided into three subsets: (1) models which were primarily hydrocarbon, with dispersion and π–π interactions as the dominant intermolecular forces, (2) models which contained polar groups, such as etheral oxygen and heterocyclic amine, but which exhibited the same general types of interactions as group 1, and (3) models which contained hydrogen-bond donor functionalities. The preasphaltene samples were isolated from different liquefaction runs and were separated into narrow molecular weight fractions by preparative gel permeation chromatography.

40283 (DOE/PC/88940–T4) **Fundamental studies in production of C_2-C_4 hydrocarbons from coal: Progress report No. 6, December 1, 1989–February 28, 1990.** Wiser, W.H.; Oblad, A.G. Utah Univ., Salt Lake City, UT (USA). Dept. of Fuels Engineering. Mar 1990. 3p. Sponsored by U.S. DOE Fossil Energy. DOE Contract FG22-88PC88940. Order Number DE90014600. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

An envelope of parameter values has been experimentally identified in our laboratory, heretofore unexplored, for the catalytic hydrogenation and hydrocracking of coal which leads to yields of C_2–C_4 hydrocarbons in excess of 50 weight percent of the coal, in a direct, single stage process under mild conditions. In this research program, an innovative and highly sophisticated reactor system, designed and constructed by us, will obtain data to define the reaction pathways leading directly from coal to high yields of C_2–C_4 hydrocarbons, and to provide insight into the mechanisms

of the conversion reactions. A computer program will be developed to define the maximum yields of C_2, C_3, and C_4 hydrocarbons thermodynamically possible in such a system, as a function of temperature, pressure and percent steam in the steam-hydrogen stream to the reactor, for the type of dual-functional catalyst identified as essential to the conversion process. The process will then be optimized for production of each of the hydrocarbons C_2, C_3, and C_4, and for production of olefins among these hydrocarbons.

40284 (EGG-M-89236) **Microbial desulfurization of alkali solubilized Illinois No. 6 coal.** Wey, J.E.; Jolley, J.G.; Dugan, P.R.; Stoner, D.L. EG and G Idaho, Inc., Idaho Falls, ID (USA). [1989]. 4p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC07-76ID01570. (CONF-890916-6: 6. annual international Pittsburgh coal conference, Pittsburgh, PA (USA), 25-29 Sep 1989). Order Number DE90013868. Available from NTIS, PC A02/MF A01 - OSTI.

Bacterial cultures capable of dibenzothiophene (DBT) degradation were tested for their ability to modify the organosulfur constituents in an alkali solubilized Illinois No. 6 coal product. Buffered solutions of solubilized coal were incubated one week with bacterial cultures and subsequently analyzed by Fourier transform infrared spectroscopy (FTIR) and elemental microanalysis. 11 refs., 3 figs., 2 tabs.

40285 (IS-T-1475) **NMR [nuclear magnetic resonance] study of the influence of adsorbed sulfur on hydrogen chemisorption on supported ruthenium catalysts.** Bhatia, Sandeep. Iowa State Univ. of Science and Technology, Ames, IA (USA). [1989]. 81p. Sponsored by U.S. DOE Energy Research. DOE Contract W-7405-ENG-82. Order Number DE90014418. Available from NTIS, PC A05/MF A01 - OSTI; GPO Dep.

Catalyst poisoning induced by sulfur is one of the most severe problems associated with the commercial use of metal catalysts. It is a major problem in applications such as methanation of coal synthesis gas or reforming of naphthas. Sulfur atoms bond so strongly to metal surfaces that marked activity reduction occurs at low gas-phase concentrations of sulfur containing compounds. The purpose of this study was to determine the effects of adsorbed sulfur on the adsorption of hydrogen on ruthenium, a highly active catalyst for many reactions including the Fischer Tropsch synthesis reaction. Sulfur is a common impurity for methanation and Fischer Tropsch synthesis catalysts and the effects of the sulfur are complex.

40286 Addition of basic nitrogen promoters to enhance low severity two-stage coal liquefaction and coal/oil coprocessing. Miller, R.L. (Colorado School of Mines, Golden (USA)); Baldwin, R.M.; Kennar, D.R. *Preprints of Papers, American Chemical Society, Division of Fuel Chemistry (USA),* 35(1): 9-16 (1990). DOE Contract FG22-86PC90909. (CONF-900402--: 199. national meeting of the American Chemical Society, Boston, MA (USA), 22-27 Apr 1990).

Conventional coal dissolution theories have held that coal must be heated to temperatures near 400°-450°C causing thermal rupture of various labile bonds within the three dimensional cross-linked coal structure and formation of free radical intermediates. Stabilizing the free radicals with hydrogen radicals results in products of lower molecular weight than the parent coal. The objective of this paper is to describe single-stage low severity coal/oil coprocessing data using basic nitrogen promoters. Initial results from two-stage (low severity thermal dissolution 1st stage, conventional catalytic upgrading 2nd stage) batch reactor experiments are also presented.

40287 The effects of hydrothermal pretreatment on the liquefaction of coal. Ross, D.S. (SRI International, Menlo Park, CA (USA)); Hirschon, A. *Preprints of Papers, American Chemical Society, Division of Fuel Chemistry (USA),* 35(1): 37-45 (1990). (CONF-900402--: 199. national meeting of the American Chemical Society, Boston, MA (USA), 22-27 Apr 1990).

The effects of aqueous pretreatment on coal and the benefits that can develop for liquefaction or mild gasification are areas of current interest. Most of the work has been conducted with water vapor, and current accounts include that of Bienkowski et al, who found that water vapor pretreatment enhanced liquefaction. Their work has focused on the use of liquid water at elevated temperatures, both as a probe into coal structure, and as a pretreatment for coal liquefaction. In the work summarized here, the authors examined the effects of hydrothermal pretreatment at 250°C on conversion of Illinois No. 6 coal (PSOC 1098, and Argonne Premium Coal Bank samples) in tetralin.

40288 Coal solubilization through c-alkylation. Chatterjee, K. (Univ. of Chicago, IL (USA)); Miyake, M.; Stock, L.M. *Preprints of Papers, American Chemical Society, Division of Fuel Chemistry (USA),* 35(1): 46-50 (1990). (CONF-900402--: 199. national meeting of the American Chemical Society, Boston, MA (USA), 22-27 Apr 1990).

C-Alkylation is an attractive process for the disruption of the intermolecular polarization forces that contribute to the binding of coal molecules in the solid state (1,2). This contribution concerns the use of a powerfully basic reaction system that consists of a 1:1 mixture of n-butyllithium and potassium t-butoxide, super base, to promote the C-alkylation reaction of coal with an alkyl halide (3). This choice was prompted by the work of Bates and his coworkers who showed that dimethylphenol was readily converted to diethylanisole with n-butylithium-potassium t-butoxide and methyl iodide (4).

40289 Low-temperature catalytic coal hydrogenation: Pretreatment for liquefaction. Derbyshire, F. (Univ. of Kentucky, Lexington (USA)); Davis, A.; Schobert, H.; Stansberry, P. *Preprints of Papers, American Chemical Society, Division of Fuel Chemistry (USA),* 35(1): 51-60 (1990). (CONF-900402--: 199. national meeting of the American Chemical Society, Boston, MA (USA), 22-27 Apr 1990).

There are certain advantages to liquefying coals in separate and successive stages which are operated under different reaction conditions (1). For practical reasons, most investigations have considered only two stages. Differences of opinion exist about whether the preferred reaction sequence is from low to high or high to low temperature. (Essentially, the low temperature range is typically 250-350°C and the high temperature range 400°C and above. Individual studies will depart from this general distinction). This paper describes the findings of a program of research which was intended to examine the relative effects of catalyst type, coal rank and solvent composition on temperature-staged liquefaction.

40290 Studies of coal pretreatment in direct liquefaction. Serio, M.A. (Advanced Fuel Research, Inc., Hartford, CT (USA)); Solomon, P.R.; Kroo, E.; Bassilakis, R.; Malhotra, R.; McMillen, D. *Preprints of Papers, American Chemical Society, Division of Fuel Chemistry (USA),* 35(1): 61-69 (1990). DOE Contract AC22-88PC88814. (CONF-900402--: 199. national meeting of the American Chemical Society, Boston, MA (USA), 22-27 Apr 1990).

Studies have been done on pretreatment of three coals from the Argonne Sample bank (Zap Lignite, Wyodak subbituminous, and Illinois No. 6 bituminous). For each coal, samples of dried, ion-exchanged (using ammonium acetate), methylated, and demineralized (using HCl/HF) coal were prepared. The starting samples were characterized by several techniques (FT-IR, TG-FTIR, SEM/x-ray, FIMS, elemental analysis). Liquefaction experiments were done at 400°C (30 min) in dihydrophenanthrene (DPH). The trends for improved liquefaction yields were found to parallel trends for improved tar yields and lower CO_2 yields in a programmed pyrolysis treatment.

40291 Copper based sorbent for hot gas cleanup. Desai, M. (ElectroChem, Inc., Woburn, MA (USA)); Brown, F.; Chamberland, B.; Jalan, V. *Preprints of Papers, American Chemical Society, Division of Fuel Chemistry (USA),* 35(1): 87-94 (1990). (CONF-900402--: 199. national meeting of the American Chemical Society, Boston, MA (USA), 22-27 Apr 1990).

Coal-derived fuel gases contain significant levels of sulfur and other contaminants. full realization of the tremendous commercial potential of coal gas fueled power plants and related technologies awaits the development of an inexpensive and reliable method for the removal of these contaminants. A family of copper manganese oxide sorbents was identified as a high temperature regenerable sulfur sorbent in the METC process. The objectives of the development program include the study of sorbent properties such as

physical characteristic, durability, temperature stability, life, rate of utilization, and development of design parameters. Copper manganese oxides provide excellent reactivity, high sulfur capacity, and complete chemical regenerability.

40292 Enhanced durability of high-temperature desulfurization sorbents for moving-bed applications. Ayala, R.E. (GE Corporate Research and Development, Schenectady, NY (USA)); Gal, E.; Gangwal, S.K.; Jain, S. *Preprints of Papers, American Chemical Society, Division of Fuel Chemistry (USA),* 35(1): 120-127 (1990). (CONF-900402–: 199. national meeting of the American Chemical Society, Boston, MA (USA), 22-27 Apr 1990).

Sulfur removal will be mandatory for all power generation coal gas applications in order to comply with future environmental standards. Two promising technologies that are currently being optimized for coal-based power generation are the integrated gasification combined cycle (IGCC) and the gasifier/molten carbonate fuel cell (MCFC) systems. Zinc ferrite is currently the leading candidate to serve as a sulfur removal agent in the IGCC systems. GE has developed a patented moving-bed coal gas desulfurization system that has been shown to achieve a reduction in complexity and cost in a simplified IGCC system relative to conventional IGCC configurations (Cook et al, 1988).

40293 Desulfurization of hot coal-gas in a high-pressure fluid-bed reactor. Gangwal, S.K. (Research Triangle Institute, NC (USA)); Harkins, S.M.; Jain, S.C. *Preprints of Papers, American Chemical Society, Division of Fuel Chemistry (USA),* 35(1): 161-169 (1990). (CONF-900402–: 199. national meeting of the American Chemical Society, Boston, MA (USA), 22-27 Apr 1990).

Zinc ferrite, a regenerable mixed-metal oxide, is a leading sorbent for removal of H_2S from hot coal-derived gas streams for integrated gasification combined cycle (IGCC) applications. Due to several potential advantages of fluid-bed operation, a high-temperature high-pressure bench-scale reactor was constructed and commissioned for testing in the fluid-bed mode. Zinc ferrite was tested at a superficial velocity to minimum fluidization velocity ratio of 3.0. Multicycle testing at 15 atm and 600°C with 5,000 ppmv H_2S in the inlet simulated fluid-bed coal gasifier (KRW) gas showed that zinc ferrite consistently reduced the H_2s to under 20 ppmv, in a single-stage fluidized bed at a superficial residence time of ~3 seconds. Prior to reaching a bed outlet H_2S concentration of 100 ppmv, a sulfur pickup of 12 g per 100 g sorbent was achieved.

40294 Pyrolysis of surface-immobilized model compounds. Mechanistic implications for the thermal chemistry of coal. Buchanan, A.C. III (Oak Ridge National Lab., TN (USA)); Britt, P.F.; Poutsma, M.L. *Preprints of Papers, American Chemical Society, Division of Fuel Chemistry (USA),* 35(1): 217-224 (1990). DOE Contract AC05-84OR21400. (CONF-900402–: 199. national meeting of the American Chemical Society, Boston, MA (USA), 22-27 Apr 1990).

The thermal reactivity of coal forms the basis of many processes devised for coal utilization. Although much is known about the kinetics of coal pyrolysis, a detailed molecular level mechanistic understanding is hampered by the complex chemical structure of coal. The authors research has been investigating the potential role that the cross-linked network structure of coal may play in perturbing free-radical reactions associated with coal thermolysis. In order to assess the potential impact of restricted transport on thermal reaction pathways, they have modeled the phenomenon experimentally by studying organic model compounds that are covalently linked to an inert silica surface. The experimental methodology and significant results from studies of the thermolysis of surface-attached $Ph(CH_2)_nPh$ (n = 0-4) at 345-400°C will be briefly surveyed.

40295 Reactive intermediates in coal liquefaction. Schroeder, K.T. (Pittsburgh Energy Technology Center, PA (USA)); Bockrath, B.C.; Smith, M.R.; Davis, H.; Miller, R.D. *Preprints of Papers, American Chemical Society, Division of Fuel Chemistry (USA),* 35(1): 225-231 (1990). (CONF-900402–: 199. national meeting of the American Chemical Society, Boston, MA (USA), 22-27 Apr 1990).

Investigations into the mechanisms of coal liquefaction are hampered by the difficulty in obtaining information at the molecular level. The chemical structure of the starting coal is poorly defined and the products can be only partially identified. Traditionally, mechanisms have been discussed in terms of the yields of phenomenologically defined fractions such as oils (pentane soluble product) and asphaltenes (pentane insoluble, benzene soluble products). While these pseudo-components have practical importance, their relation to molecular processes is unsure. An approach to understanding the physical organic chemistry of liquefaction using a method to monitor the presence of reactive intermediates has shown promise (1,2). This approach makes use of probe compounds to measure the prevalence of selected reactive intermediates. A further extension of this work is described here.

40296 Physical organic chemistry of coal liquefaction. Bockrath, B. (Pittsburgh Energy Technology Center, PA (USA)); Illig, E.; Hough, M. *Preprints of Papers, American Chemical Society, Division of Fuel Chemistry (USA),* 35(1): 232-240 (1990). (CONF-900402–: 199. national meeting of the American Chemical Society, Boston, MA (USA), 22-27 Apr 1990).

The direct conversion of coal to liquid fuels is a complex chemical and physical process. The challenge of developing an understanding of the molecular details of this process has provided physical organic chemists great opportunities to ply their trade. Direct liquefaction is most often practiced by the addition of hydrogen to coal in some manner. Some form of hydrogen transfer is involved in nearly every chemical mechanism of importance to liquefaction (1). To fully understand the hydrogen transfer chemistry is to understand a large portion of the whole of liquefaction chemistry. An approach to the problem of hydrogen transfer chemistry has been recently taken up. The coal-hydrogen-catalyst interaction is of fundamental importance to liquefaction schemes, and particularly those that focus on low severity processing conditions. A pulse-flow microreactor was constructed and demonstrated to be a useful means to study this chemistry.

40297 Reservations concerning the use of model compounds for coals. Larsen, J. (Lehigh Univ., Bethlehem, PA (USA)). *Preprints of Papers, American Chemical Society, Division of Fuel Chemistry (USA),* 35(2): 376-380 (1990). (CONF-900402–: 199. national meeting of the American Chemical Society, Boston, MA (USA), 22-27 Apr 1990).

There is abundant evidence for the existence of a variety of radical processes occurring during coal conversion. The snarl of competing and parallel reactions has not yet been unraveled. There exists evidence that the principle pathways may not be solely radical reactions, and this evidence has been largely ignored. It seems clear that one must deal with complex radical chemistry when considering coal conversion and coal pyrolysis. Whether radical reactions are the only pathways which must be considered is not yet clear.

40298 A search for the radical hydrogen transfer pathway in coal hydroliquefaction. Autrey, T. (Pacific Northwest Lab., Richland, WA (USA)); Franz, J.A. *Preprints of Papers, American Chemical Society, Division of Fuel Chemistry (USA),* 35(2): 381-386 (1990). DOE Contract AC06-76RL01830. (CONF-900402–: 199. national meeting of the American Chemical Society, Boston, MA (USA), 22-27 Apr 1990).

It is generally accepted that the formation of petroleum liquids produced in the thermal liquefaction of coal can not be completely explained by simple homolytic cleavage of strong linkages in coal structures. Model compound studies have been employed to elucite the mechanisms of scission of strong bonds in coal structures and have provided useful information for increasing the efficiency of the coal liquefaction processes (1).

40299 Modeling coal liquefaction: Decomposition of 4-(1-naphthylmethyl)bibenzyl catalyzed by carbon black. Farcasiu, M. (Pittsburgh Energy Technology Center, PA (USA)); Smith, C. *Preprints of Papers, American Chemical Society, Division of Fuel Chemistry (USA),* 35(2): 404-413 (1990). DOE Contract AC05-76OR00033. (CONF-900402–: 199. national meeting of the American Chemical Society, Boston, MA (USA), 22-27 Apr 1990).

The early stages of coal liquefaction involve cleavage of methylene and ethylene bridges connecting aromatic rings. The authors modeled this process by the reaction of 4-(1-naphthylmethyl)bibenzyl (I) in the presence of a hydrogen donor

(9,10-dihydrophenanthrene). The reactions were conducted over a range of temperatures (320-430°C) and reaction times (30-90 min). They found that the bond between the methylene group and the naphthalene ring and the methylene to methylene bond of bibenzyl moiety are broken with equal probability. Addition of carbon black (BP 2000) as catalyst (2-10%) increases significantly the conversion of I. This particular carbon black is, a very active and selective catalyst for the cleavage of the naphthyl-to-methylene bond.

40300 Use of model compounds in coal structure and reactivity studies. Winans, R.E. (Argonne National Lab., IL (USA)); Hayatsu, R.; Carrado, K.A.; Botto, R.E.; Squires, T.G. *Preprints of Papers, American Chemical Society, Division of Fuel Chemistry (USA),* 35(2): 423-429 (1990). DOE Contract W-31-109-ENG-38. (CONF-900402--: 199. national meeting of the American Chemical Society, Boston, MA (USA), 22-27 Apr 1990).

The interpretation of data from chemical and thermal reactions of coals is often facilitated and can be strengthened by investigating analogous reactions in appropriate model systems. While coal models have ranged from small molecules to polymers to synthetically coalified biomolecules and biomacromolecules, it appears that there are dangers in extrapolating the behavior of small, soluble molecules to that of solid coal. They have found that polymers and synthetic coals are much more appropriate models for coal behavior. In the present report, pyrolysis data from the latter models and coals will be compared and contrasted.

40301 Synthesis and conversion studies of polymeric models for low-rank coals. McMillen, D.F. (SRI International, Menlo Park, CA (USA)); Malhotra, R.; Serio, M.A. *Preprints of Papers, American Chemical Society, Division of Fuel Chemistry (USA),* 35(2): 430-437 (1990). DOE Contract AC22-88PC88814. (CONF-900402--: 199. national meeting of the American Chemical Society, Boston, MA (USA), 22-27 Apr 1990).

Efforts to understand the key chemical reactions responsible for coal conversion have been severely hindered over the years by the necessity of having to infer a complex sequence of chemical reactions for a substrate, coal, whose critical linkages are basically unknown. This paper reports the initial results of an effort to use model structures that (1) have inter-cluster linkages that are perhaps more representative of those in coals, and (2) are incorporated into polymeric networks in order that mass transport and other effects that can be important in heterogeneous systems might be more appropriately mimicked.

40302 Hydroquinone copolymers: Models for retrograde reactions in liquefaction processing. Olson, E.S. (Univ. of North Dakota, Grand Forks (USA)); Sharma, R.K.; Radonovich, L.J. Jr.; Heintz, M.J.; Diehl, J.W. *Preprints of Papers, American Chemical Society, Division of Fuel Chemistry (USA),* 35(2): 438-441 (1990). DOE Contract FC21-86MC10637. (CONF-900402--: 199. national meeting of the American Chemical Society, Boston, MA (USA), 22-27 Apr 1990).

The identification of structures responsible for retrograde reactions is a high priority research objective in coal liquefaction. Interest has focused on the cleavage of benzyl aryl ethers and subsequent polymerization of the fragments. In their work, the reactions of the polyethers prepared by reaction of bis(bromomethyl)naphthalene with hydroquinone were investigated in a tetralin system. Analysis of the products from the copolymers demonstrated that almost all of the naphthyl moieties were converted to dimethylnaphthalene, whereas the hydroquinone groups were converted to very high molecular weight macromolecules.

40303 Advanced in the FG-DVC model of coal devolatilization. Solomon, P.R. (Advanced Fuel Research, Inc., Hartford, CT (USA)); Serio, M.A.; Hamblen, D.G.; Yu, Z.Z.; Charpenay, S. *Preprints of Papers, American Chemical Society, Division of Fuel Chemistry (USA),* 35(2): 479-488 (1990). DOE Contract AC21-86MC23075. (CONF-900402--: 199. national meeting of the American Chemical Society, Boston, MA (USA), 22-27 Apr 1990).

The FG-DVC general model for coal devolatilization, which combines a functional group (FG) model for gas evolution and a statistical depolymerization, vaporization, and crosslinking (DVC) model for tar formation, has previously been presented (1). Since the presentation of the original FG-DVC model, a number of improvements have been made. First they have added a second class of material, polymethylenes, to the macromolecular network. An approximation is presented which includes the evolution of tar molecules and is based on a previously presented two coordination number percolation theory (6).

40304 Mineral matter effects in coal pyrolysis. Bae, I. (Univ. of Utah, Salt Lake (USA)); Anani, M.; Maswadeh, W.; Yun, Yongseung; Meuzelaar, H.; DuBow, J. *Preprints of Papers, American Chemical Society, Division of Fuel Chemistry (USA),* 35(2): 489-495 (1990). (CONF-900402--: 199. national meeting of the American Chemical Society, Boston, MA (USA), 22-27 Apr 1990).

Coal pyrolysis is a fundamental first step in combustion processes. Yet coals exhibit a wide variation in pyrolysis behaviors. The origins of these wide variations are, for a given set of experimental conditions, both structural and compositional in nature. In the present paper the mineral matter effects on coal pyrolysis are being analyzed using an approach whereby observable spectroscopic (TG/MS) differences in the pyrolytic decomposition between fresh coal and demineralized coal are reconstructed from the sum of mineral matter effects on pyrolysis arising from adding back, singly and in pairs, individual minerals in various forms.

40305 Pyrolysis of plastic coals: Pore structure development and char reactivity. Matzakos, A. (Rice Univ., Houston, TX (USA)); Zygourakis, K. *Preprints of Papers, American Chemical Society, Division of Fuel Chemistry (USA),* 35(2): 505-515 (1990). (CONF-900402--: 199. national meeting of the American Chemical Society, Boston, MA (USA), 22-27 Apr 1990).

This study presents some of the authors recent experimental results on the effect of pyrolysis conditions on the macropore structure of coal chars and on their reactivity during combustion with oxygen. The variables they consider are the pyrolysis heating rate, the final heat treatment temperature (HTT), and the soak time at HTT. Pyrolysis and gasification experiments are carried out on (i) a thermogravimetric reactor that provides accurate measurements of volatile evolution and combustion rates and (ii) a microscope hot-stage reactor that allows direct observation of pyrolyzing and burning particles under a microscope. Their analysis pays particular attention to combustion at high temperatures where the heterogeneous reactions take place in the regime of strong diffusional limitations.

40306 Anion effects on calcium catalysis of low-rank coal char-steam gasification. Timpe, R.C. (Univ. of North Dakota, Grand Forks (USA)); Sears, R.E. *Preprints of Papers, American Chemical Society, Division of Fuel Chemistry (USA),* 35(2): 530-534 (1990). (CONF-900402--: 199. national meeting of the American Chemical Society, Boston, MA (USA), 22-27 Apr 1990).

Limestone (primarily $CaCO_3$) has been shown to be an excellent bed material in a fluidized-bed reactor operated at 700-800°C and atmospheric pressure for the steam gasification of coal. It not only maintains its physical integrity under these conditions but also has shown catalytic effects on a subbituminous coal-steam reaction that are comparable with the effects of an alkali salt. The study reported in this paper concerns the effect, if any, of calcium-associated anions on the reaction kinetics of the coal char-steam reaction. Apparent activation energies along with surface analyses of selected samples to determine catalyst dispersion and form will be presented.

40307 Hydrocracking with new solid acid catalysts: Low severity liquefaction products from low rank coal. Olson, E.S. (Univ. of North Dakota, Grand Forks (USA)); Diehl, J.W.; Sharma, R.K. *Preprints of Papers, American Chemical Society, Division of Fuel Chemistry (USA),* 35(2): 563-569 (1990). (CONF-900402--: 199. national meeting of the American Chemical Society, Boston, MA (USA), 22-27 Apr 1990).

Solid acid catalysts, prepared by supporting zinc chloride on silica gel and on acid-exchanged montmorillonite, were tested for catalytic hydrocracking of first stage liquefaction products from Wyodak subbituminous coal. Unsupported acid-exchanged montmorillonite was also tested. The reactions were carried out by heating the high molecular weight, THF-soluble, low-severity product with the supported zinc chloride catalyst in a microreactor at

400°C for three hours with 1,000 psig of hydrogen (repressurized at 1-hr intervals). These reactions gave good yields of distillates (53-68%), which exceeded those obtained with conventional hydrotreating catalysts under similar conditions.

40308 Dispersed phase molybdenum catalyst recovery in coprocessing. Krastman, D. (Pittsburgh Energy Technology Center, PA (USA)); Utz, B.R.; Cugini, A.V.; Lett, R.G. *Preprints of Papers, American Chemical Society, Division of Fuel Chemistry (USA),* 35(2): 570-576 (1990). (CONF-900402–: 199. national meeting of the American Chemical Society, Boston, MA (USA), 22-27 Apr 1990).

Dispersed-phase molybdenum catalysts are being used at PETC to enhance the simultaneous conversion of petroleum bottoms material and coal to distillate products. A series of tests were performed in micro-autoclaves, 1-liter semi-batch stirred autoclaves, and a 1-liter continuous unit aimed at maximizing the production distillates while minimizing the catalyst requirements. Similar products yield structures and conversions have been demonstrated using molybdenum concentrations from 200 ppm (based on coal weight) to 1,000 ppm in the 1-liter continuous unit. Dispersed-phase catalysis using molybdenum may require catalyst recovery. This paper examines the potential for the recovery of a dispersed-phase molybdenum catalyst.

40309 Cyclic olefins as new hydrogen donor compounds for coal liquefaction. Bedell, M.W. (Auburn Univ., AL (USA)); Curtis, C.W. *Preprints of Papers, American Chemical Society, Division of Fuel Chemistry (USA),* 35(2): 577-583 (1990). (CONF-900402–: 199. national meeting of the American Chemical Society, Boston, MA (USA), 22-27 Apr 1990).

A new set of hydrogen donor compounds, cyclic olefins (CLO), has been evaluated to determine their effectiveness as hydrogen donors to coal. These cyclic olefins are hydroaromatic species which do not contain aromatic rings. The efficacy of these donors has been compared to conventional hydroaromatics. The CLO's under study are 1,4,5,8-tetrahydronaphthalene, also known as isotetralin, and 1,4,5,8,9,10-hexahydroanthracene. In this paper, the thermal and catalytic reactivity of the CLO's under nitrogen and hydrogen at coal liquefaction temperature is discussed. Results for the reactions of the CLO's and their conventional hydroaromatic analogues, e.g. tetralin, 9,10-dihydroanthracene, and octahydroanthracene, with Western Kentucky No. 9 coal are discussed.

0105 Products and By-Products

Refer also to citation(s) 40310

0106 Properties and Composition

Refer also to citation(s) 40282, 40308, 40344, 40345

40310 (AD-A–220167/1/XAB) **Criteria for coal-tar seal coats on airport pavements. Volume 2. Laboratory and field studies. Final report.** Shook, J.E.; Jenkins, S.W.; Gardiner, M.S.; Newcomb, D.E.; Epps, J.A. ARE, Inc., Riverdale, MD (USA). Jan 1990. 237p. Available from NTIS, PC A11/MF A02.

See also Volume 2, AD-A219 401.

Because coal tars are resistant to gasoline and jet fuel, they have been used for many years as a protective coating on asphalt pavements for airport parking areas, ramps, taxiways and runways. Applications include both coal tar emulsions and rubberized coal tar emulsions, applied with sand to provide skid resistance and stability to the seal costs. Volume II of the report includes the results of an experimental Laboratory and field investigation conducted at the University of Nevada at Reno. The focus on the University program was to develop test procedures that would measure workability, scuff, adhesion and fuel resistance properties of coal tar emulsion seal coats. This program developed a method for designing seal coat formulations test procedures that could be used for quality assurance purposes. Volume II includes the test data generated in the study, including measurements made on field sections.

40311 (PB–90-222209/XAB) **Mathematical modeling of spontaneous heating of a coal bed. Report of Investigations/1990.** Edwards, J.C. Bureau of Mines, Pittsburgh, PA (USA). Pittsburgh Research Center. May 1989. 23p. (BUMINES-RI–9296). Available from NTIS, PC A03/MF A01.

Library of Congress catalog card no. 89-600273.

To have the capability to predict the development of localized spontaneous heating within a porous coalbed that is subjected to forced air ventilation or in an otherwise quiescent environment in which buoyancy develops, the Bureau of Mines developed three time-dependent mathematical models, which were used to calculate the temperature increase associated with chemisorption of oxygen by the coal. In each model, spontaneous heating is driven by an Arrhenius first-order reaction between the oxygen and coal. Two models are two-dimensional, and one is one-dimensional. In the first two-dimensional model, a constant-velocity forced convection air-flow is specified; and in the other, buoyant flow is allowed to develop in the absence of forced convection. The third model evaluates the airflow from Darcy's law and a specification of the pressure at the surface of a one-dimensional porous coalbed. Numerical computations demonstrated how each model could be used to predict the onset of spontaneous heating when the porous coalbed was subjected to constraints of an imposed internal heat source or a high-temperature airflow. The effects of particle size and coalbed compaction upon spontaneous heating were examined with the third model.

40312 (PB–90-870189/XAB) **Fly ash: Analysis and characterization. January 1970-April 1990 (A Bibliography from the COMPENDEX data base). Report for January 1970-April 1990.** National Technical Information Service, Springfield, VA (USA). May 1990. 76p. Available from NTISPC N01/MF N01.

Supersedes PB–89-857379.

This bibliography contains citations concerning the analysis and characterization of fly ash. Chemical analysis, particle size distribution, toxicity, mineralogical analysis, and surface adsorption are among the topics considered. New trends in analytical instrumentation and collection as applied to fly ash are also presented. (This updated bibliography contains 164 citations, 18 of which are new entries to the previous edition.)

40313 Penetrant transport in coal network structures between 35°C and 150°C. Olivares, J.M. (Purdue Univ., West Lafayette, IN (USA)); Peppas, N.A. *Preprints of Papers, American Chemical Society, Division of Fuel Chemistry (USA),* 35(2): 292-298 (1990). (CONF-900402–: 199. national meeting of the American Chemical Society, Boston, MA (USA), 22-27 Apr 1990).

The dynamics of penetrant swelling of macromolecular coal systems can provide important information about the structure of the coal itself and its interactions with vapors and liquids. For example, it is possible to identify the thermodynamic state of the coal network. Inflections or dips in the time-sorption curve may be attributed to specific relaxations of the macromolecular coal system. If the coal is in the glassy state, one can determine whether the sorption is due to Fickian diffusion and/or due to relaxations of the macromolecular coal chains and estimate values of the diffusion coefficient and of the relaxation constants. Up to now only one research contribution from their laboratory (8) has examined the change in temperature as a method to decouple the diffusion and relaxation phenomena. In the present work they examine the transport of various penetrants in coal sections at moderate temperatures.

40314 Coal solubility and swelling. Painter, P. (Pennsylvanian State Univ., University Park (USA)); Park, Y.; Graf, J.; Sobkowiak, M.; Coleman, M. *Preprints of Papers, American Chemical Society, Division of Fuel Chemistry (USA),* 35(2): 307-318 (1990). DOE Contract FG02-86ER13537. (CONF-900402–: 199. national meeting of the American Chemical Society, Boston, MA (USA), 22-27 Apr 1990).

The characterization of coal as a macromolecular network has resulted in a significant advance in their understanding of this complex material. By applying the theories of Paul Flory, the solubility and swelling of a coal can be used as a probe of structure. The authors have recently developed an association model that can account for hydrogen bonding in polymer mixtures. Here the authors will concern themselves with a brief outline of some of their most important recent results.

40315 Coal analysis by TG-FTIR. Solomon, P.R. (Advanced Fuel Research, Inc., Hartford, CT (USA)); Serio, M.A.; Carangelo, R.M.; Bassilakis, R. *Preprints of Papers, American Chemical Society, Division of Fuel Chemistry (USA),* 35(2): 334-343 (1990). DOE Contract AC21-86MC23075. (CONF-900402–: 199. national meeting of the American Chemical Society, Boston, MA (USA), 22-27 Apr 1990).

A complimentary technique, evolved product analysis, has been employed to study pyrolysis product distributions and kinetics (11-18) functional group compositions (14,19-21), and temperature programmed desorption (22-24). FTIR analysis of evolved products has advantages over mass spectroscopy in allowing analysis of very heavy products, and over gas chromatography in speed.

40316 Aging studies of bituminous coal by ESCA (Electron Spectroscopy for Chemical Analysis) and FTIR (Fourier Transform Infrared Spectroscopy). Weitzsacker, C.L. (Univ. of Buffalo, NY (USA)); Schmidt, J.J. Gardella, J.J. Jr. *Preprints of Papers, American Chemical Society, Division of Fuel Chemistry (USA),* 35(2): 344-351 (1990). DOE Contract AC22-87PC79880. (CONF-900402–: 199. national meeting of the American Chemical Society, Boston, MA (USA), 22-27 Apr 1990).

Electron Spectroscopy for Chemical Analysis (ESCA or XPS) and transmission Fourier Transform Infrared Spectroscopy (FTIR) were used to examine aged bituminous coals. The coals were obtained from the Illinois No. 6, Kentucky No. 9, Pittsburgh and Upper Freeport seams. The coals were stored under either ambient air, mine site tap water or nitrogen as they were exposed first to cold weather (10 C), warm weather (25 C) and the following cold season. Samples over the time periods were analyzed as raw, milled and processed coals. Emphasis was placed on changes in C, O, N and S functionalities on the surface by ESCA analysis, and in the bulk by transmission FTIR.

40317 Iron k-edge EXAFS investigation of ash deposits from coal combustion. Sundaram, M.S. (Brookhaven National Lab., Upton, NY (USA)); Butcher, T.A.; Krishna, C.R.; Manowitz, B.M.; Zwillenberg, M.L. *Preprints of Papers, American Chemical Society, Division of Fuel Chemistry (USA),* 35(2): 370-375 (1990). DOE Contract AC02-76CH00016. (CONF-900402–: 199. national meeting of the American Chemical Society, Boston, MA (USA), 22-27 Apr 1990).

The formation and buildup of the slag deposits on wall tubes is one of the most serious problems in pulverized coal combustion for power generation. This phenomenon, traditionally called wall slagging, is known for its undesirable effects on heat and mass transfer. Further work in understanding the chemical structure of the slags should be profitable in relating the major issue of the influence of coal mineral matter on the operational characteristics of the commercial boilers. Application of Synchrotron-Induced X-Ray Absorption Fine Structure (EXAFS) in such studies was explored and an understanding of the local structure of the iron atoms in the slags derived from a commercial boiler forms the scope of this study.

40318 Thermolytic cleavage of selected ether linkages at mild temperatures. Chawla, B. (Center for Applied Energy Research, Lexington, KY (USA)); Davis, B.H.; Shi, Buchang; Guthrie, R.D. *Preprints of Papers, American Chemical Society, Division of Fuel Chemistry (USA),* 35(2): 387-393 (1990). (CONF-900402–: 199. national meeting of the American Chemical Society, Boston, MA (USA), 22-27 Apr 1990).

Most of the reported studies describing the thermolysis of coal model compounds, ethers in particular, have been performed at much higher temperatures than used in coal liquefaction processes. Obviously, conclusions derived from thermolysis at the higher temperatures cannot be applied directly toward understanding of coal dissolution and/or thermolysis processes. Therefore, they initiated studies on the chemistry of thermolysis of four arylmethyl aryl ethers which undergo thermolysis to a significant extent under relatively mild reaction conditions.

40319 Investigation of organic sulfur structure as a function of coal rank. Mitra, S. (Univ. of Kentucky, Lexington (USA)); Huggins, F.E.; Shah, N.; Huffman, G.P. *Preprints of Papers, American Chemical Society, Division of Fuel Chemistry (USA),* 35(2): 364-369 (1990). (CONF-900402–: 199. national meeting of the American Chemical Society, Boston, MA (USA), 22-27 Apr 1990).

X-Ray Absorption Fine Structure (XAFS) spectroscopy is proving to be a very promising method by which information on the electronic bonding state and atomic environment of dilute elements in complex samples can be readily obtained. Of especial importance to coal science, is the technique's demonstrated ability to provide detailed information on organic sulfur in coal. In this paper, the authors present the results of an XAFS investigation into the occurrence of various forms of sulfur present in a series of coals and maceral separates of different ranks.

40320 Sulfur species in perchloroethylene and other coal extracts. Vorres, K.S. (Argonne National Lab., IL (USA)). *Preprints of Papers, American Chemical Society, Division of Fuel Chemistry (USA),* 35(2): 523-529 (1990). (CONF-900402–: 199. national meeting of the American Chemical Society, Boston, MA (USA), 22-27 Apr 1990).

Earlier work (1,2,3) has indicated that elemental sulfur can be removed from coal by the use of perchloroethylene (tetrachloroethylene). The unique ability to remove the elemental form of the sulfur has led to considerable interest in the process and mechanism of action. Under joint CRSC-EPRI sponsorship, an effort has been made to understand the species that can be removed by extraction with perchloroethylene (PCE). The effort involved the extraction of a set of coals at Eastern Illinois University by Prof. David Buchanan and coworkers, and the related effort to identify the species in the extract by the use of gas chromatography- mass spectrometry at the Argonne National Laboratory (ANL). This paper reports on the analytical work on the extracts.

0108 Waste Management

Refer also to citation(s) 40272, 40312, 40339, 40593, 40599

40321 (DOE/PC/79929–9) **NO_x-char reactions: Kinetics and transport aspects: Quarterly technical progress report, 1 January 1990–31 March 1990.** Calo, J.M.; Suuberg, E.M.; Teng, H.; Milosavljevic, I.D. Brown Univ., Providence, RI (USA). Div. of Engineering. [1990]. 9p. Sponsored by U.S. DOE Fossil Energy. DOE Contract FG22-87PC79929. Order Number DE90013785. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The carbon selected for study was derived from a phenol-formaldehyde resin, the oxidation kinetics (with O_2) of which had been extensively studied previously. This material has been shown to be a reasonable model for coal chars, but without the complexity associated with the heterogeneity of coal and its possibly catalytic mineral components. In the first phases of the project, the global kinetics of NO with char were established. As described in the previous quarterly, the interest has now turned to providing the detailed mechanistic explanation that gives rise to the observed global behavior. The focus of this work has been the role of surface oxide species in the mechanism. This report builds upon the results described in the seventh and eighth quarterly reports. The focus here is on the first chemisorption step, as opposed to the desorption step, as in the earlier quarterlies. 9 refs., 3 figs., 4 tabs.

40322 (IEACR–24) **NO_x control technologies for coal combustion.** Hjalmarsson, A.K. IEA Coal Research, London (UK). ©Jun 1990. 102p. Sponsored by International Energy Agency. Available from IEA Coal Research, Gemini House, 10-18 Putney Hill, London SW15 6AA, United Kingdom.

This report describes the state of the art of NO_x control technologies for coal combustion and gives an overview of the technologies currently used including operational experiences. The emphasis is on commercial or near-commercial technologies used for coal-fired plants. The information used is mainly from published sources, with some further information from suppliers and users of the technologies. 240 refs., 40 figs., 28 tabs.

40323 (PB–90-220724/XAB) **Genetic and biochemical studies with Thiobacillus ferrooxidans for enhanced metal recovery from leach piles and coal waste.** Cox, J.C. Martek Corp., Columbia, MD (USA). 11 Sep 1987. 32p. Available from NTIS, PC A03/MF A01.

The objective of the study was to isolate and begin characterization of toxic metal resistant strains of Thiobacillus Ferrooxidans. Chemical mutagenesis was performed and strains resistant to one of each of five metals were selected. The metals used were selenium, arsenic, mercury, silver, and cadmium. The strains selected were resistant to concentrations of toxic metal at least 10 to 15-fold higher than would completely inhibit growth and iron oxidation of wild-type T-Ferrooxidans. Analysis of the mutant strains showed that growth rate and iron oxidase activity were unaffected by the toxic metals. These strains could potentially catalyze a higher rate of metal leaching.

40324 (PB–90-870734/XAB) **Leachate treatment. January 1978-February 1990 (A Bibliography from Pollution Abstracts). Report for January 1978-February 1990.** National Technical Information Service, Springfield, VA (USA). Jun 1990. 73p. Available from NTISPC N01/MF N01.

Supersedes PB–89-860423.

This bibliography contains citations concerning a variety of methods used in the treatment of leachates. Solvent extraction, lagooning, ultrafiltration, and activated sludge are among the techniques considered. Leachate from landfills, coal piles, and chemical wastes is discussed. (This updated bibliography contains 165 citations, 18 of which are new entries to the previous edition.)

40325 SEM microanalysis techniques in demonstration of sulfur capture by slag and sorbents during gasification of coal in a Texaco gasifier. Laurion, T.A. (Texaco Research Center, Beacon, NY (USA)); Najjar, M.S.; McKeon, R.J. *Preprints of Papers, American Chemical Society, Division of Fuel Chemistry (USA),* 35(1): 95-103 (1990). (CONF-900402–: 199. national meeting of the American Chemical Society, Boston, MA (USA), 22-27 Apr 1990).

In Texaco's Coal Gasification Process, a significant portion of desulfurization of the product gas (synthesis gas, syngas) may be achieved by slag capture in the gasification step when various sorbents are added to the coal slurry. For example, when iron oxide is added to the coal slurry, sulfur is captured primarily in a discrete iron oxysulfide phase and to a lesser degree in the glassy silicates phase. Evidence confirming the success of the sorbents approach was gathered through high-temperature, high-pressure bench scale microreactor experiments as well as those with a pilot unit gasifer at Texaco's Montebello, CA research facility. The role of optical and scanning electron microscopy (SEM) in discerning and analyzing the phases and obtaining approximate phase quantitation are presented.

40326 Integration and testing of hot desulfurization and the Texaco coal gasification process for power generation. Robin, A.M. (Texaco Inc., Montebello, CA (USA)); Wu, J.C.; Kassman, J.S. *Preprints of Papers, American Chemical Society, Division of Fuel Chemistry (USA),* 35(1): 188-195 (1990). (CONF-900402–: 199. national meeting of the American Chemical Society, Boston, MA (USA), 22-27 Apr 1990).

The overall objective of this project is to develop and demonstrate an improved, high efficiency, integrated coal gasification cycle (IGCC) electric power generation system on a process development unit (PDU) scale. The work includes investigations of in-situ desulfurization and hot gas cleanup as applied to the Texaco Coal Gasification Process. New specialized instrumentation, being developed by DOE/METC for coal gasification, also will be tested during this project.

40327 Direct sulfur recovery process for elemental sulfur recovery from gas. Dorchak, T.P. (Morgantown Energy Technology Center, WV (USA)); Gangwal, S.K. *Preprints of Papers, American Chemical Society, Division of Fuel Chemistry (USA),* 35(1): 207-216 (1990). (CONF-900402–: 199. national meeting of the American Chemical Society, Boston, MA (USA), 22-27 Apr 1990).

Research Triangle Institute, under contract to the US Department of Energy, has investigated several processes for recovering elemental sulfur from tail-gas that contains SO_2. The work focuses on a dilute tail-gas that is produced by the oxidation regeneration of mixed metal oxide sorbents. The sorbents have been proposed for hot gas cleanup of raw coal gas, upstream of a gas turbine in an integrated, gasification/combined-cycle system. It was found that elemental sulfur could be continuously recovered from the tail-gas, thereby eliminating the Claus processing. In a single stage, over 90% of the SO_2 was converted to elemental sulfur using the new direct recovery process (DSRP). In a two-staged system, overall recoveries of over 99.5% are expected.

0109 Environmental Aspects

Refer also to citation(s) 40279, 40338, 41550, 41578, 41579, 41580, 41581, 41583, 41665

40328 (ANL/EAIS/TM–12) **The Commercial and Residential Energy Use and Emissions Simulation System (CRESS): Selection process, structure, and capabilities.** McDonald, J.F. (Illinois Univ., Chicago, IL (USA). Dept. of Economics); South, D.W. Argonne National Lab., IL (USA). Environmental Assessment and Information Sciences Div. Feb 1990. 72p. Sponsored by U.S. DOE Fossil Energy. DOE Contract W-31109-ENG-38. Order Number DE90013533. Available from NTIS, PC A05/MF A01 - OSTI; GPO Dep.

This report documents the development of the Commercial and Residential Energy Use and Emissions Simulation System (CRESS), one of the sector models developed by Argonne National Laboratory (ANL) for inclusion in the TG-I emissions model set. This report also defines the capabilities of CRESS and its configuration in the 1985 test runs conducted under Phase 1. The objectives for modeling commercial and residential emissions in the TG-I emissions model set are as follows: develop an inventory of sulfur dioxide (SO_2), nitrogen oxides (NO_x), and volatile organic compounds (VOC) emissions from the commercial and residential sectors in the 48 contiguous states and the District of Columbia for each of the years 1985, 1990, 1995, 2000, 2010, 2020, and 2030; in the development of these inventories, employ projection techniques capable of estimating the emissions totals on a state-by-state basis; and incorporate within the projection scheme the capability to: predict how emissions will vary with different baseline scenarios (and their underlying factors); and perform policy simulations. 8 figs., 11 tabs.

40329 (PB–90-208992/XAB) **Surface coal mining effects on ground water recharge. Technical report.** National Research Council, Washington, DC (USA). 27 Apr 1990. 171p. Available from NTIS, PC A08/MF A01.

Library of Congress catalog card No. 90-60773.

In response to the request from the OSM (Office of Surface Mining Reclamation and Enforcement), in March 1989 the Water Science and Technology Board formed a committee of specialists in hydrology, soil science, water quality, and law to undertake an assessment of technologies currently used to evaluate ground water recharge. The report includes chapters on regulatory aspects of the issue, the hydrology of ground water recharge, pre-mining conditions in U.S. coal mining regions, methods and impacts of mining, and techniques for quantifying ground water recharge rates. Although not the major charge of the committee's report, a discussion of the relevant water quality issues is included (Chapter 5). Chapter 7 presents the committee's conclusions and recommendations.

40330 (PB–90-210014/XAB) **Report on SEDIMOT III workshop. Held in Lexington, Kentucky on July 27-28, 1988. Technical report.** Barfield, B.J.; Warner, R.C.; Sendlein, L.V.A.; Ormsbee, L. Kentucky Univ., Lexington, KY (USA). Inst. for Mining and Minerals Research. 1988. 93p. Available from NTIS, PC A05/MF A01.

The SEDIMOT II model is a watershed hydrology and sedimentology model which has found widespread use in the design of sediment detention ponds and stormwater management basins. Several states either require the use of the model for developing surface mine and other land distributing activities, permit applications or strongly encourage its use. Because SEDIMOT II is so widely used, it was decided that modifications to the model should be made only after careful deliberation with industry, government and private users of the model. Thus, support was obtained from the Office of Surface Mining, Reclamation and Enforcement for a national workshop to discuss these issues and set guidelines for

the development of a new model known as SEDIMOT III. The report discusses these guidelines.

0110 Reserves, Geology, and Exploration

Refer also to citation(s) 40278

0120 Mining

Refer also to citation(s) 40311, 40353, 40371

40331 (PB–90-209891/XAB) **Quarterly review of methane from coal-seams technology. Volume 7, Number 3, July-September 1989.** Gas Research Inst., Chicago, IL (USA). ©1990. 54p. Available from NTIS, PC A04/MF A01.

See also PB–90-140997.

The report contains: sources of coal well information; Powder River Basin, Wyoming; greater Green River coal region, Wyoming and Colorado; Piceance Basin, Colorado; San Juan Basin, Colorado and New Mexico; Raton Basin, Colorado and New Mexico; Black Warrior Basin, Alabama; the United States coalbed methane resource; western cretaceous coal seams project; multiple coal seams project; spalling and the development of a hydraulic fracturing strategy for coal; geologic evaluation of critical production parameters for coalbed methane resources; coalbed methane opportunities in Alberta; the coalbed methane forum; eastern coalbed methane forum.

40332 (PB–90-216706/XAB) **Physical and chemical fluid interaction associated with hydraulic fracturing of coal seams. Topical report, January 1987-December 1988.** Carter, R.H.; Holditch, S.A.; Ely, J.W.; Hinkel, J.; Jeffrey, R.J. Holditch (S.A.) and Associates, Inc., Bryan, TX (USA). Apr 1989. 60p. Available from NTIS, PC A04/MF A01.

The objective was to investigate the mechanical, physical, and chemical phenomena that occur when hydraulically fracturing a coal seam reservoir. The scope of the project included both laboratory and computer simulated research efforts. High treating pressures in coals have been postulated to be caused by high concentration of coal fines increasing fluid viscosity resulting in fracture tip plugging; restrictions of fracture width due to multiple parallel fractures; and creation of horizontal or mixed mode T shaped fractures. This work has shown that only the latter two phenomena could cause the high treating pressures that have been observed. Poroelastic effects caused by coals being totally saturated with water can also result in higher treating pressures. Laboratory tests have identified several chemical additives that enhance the dewatering process. Laboratory testing of flocculating agents failed to find any chemical that would control fines and have any positive effects on coal permeability.

40333 (PB–90-222290/XAB) **Surface coal mining imagery information retrieval system. Final report.** Page, S.H. Lockheed Engineering and Management Services Co., Inc., Las Vegas, NV (USA). Jul 1981. 28p. Available from NTIS, PC A03/MF A01.

A computerized system for organizing, storing, and retrieving descriptive information about remotely-sensed data acquired over western surface coal mining sites by the Environmental Monitoring Systems Laboratory - Las Vegas (EMSL-LV), has been established. Approximately 75 sites imaged by monitoring aircraft since 1975 are organized and described by the following parameters: mine name, state, county, latitude/longitude, imagery type, month/year of data acquisition, above ground imaging altitude and scale, project number, film roll, flight or PCM number, frame or tape footage range, and descriptive comments. Information is stored in a word processor and can be retrieved via CRT display and/or paper printer. It provides a rapid and convenient method to inventory and retrieve available surface coal mining coverage and can provide a framework for similar organization of monitoring imagery over other subject areas.

40334 (PB–90-222449/XAB) **Pillar design methods for longwall mining. Information Circular/1990.** Mark, C. Bureau of Mines, Pittsburgh, PA (USA). 15 Oct 1989. 62p. (BUMINES-IC–9247). Available from NTIS, PC A04/MF A01.

Library of Congress catalog card No. 89-600380.

The U.S. Bureau of Mines report summarizes 5 years of research aimed at improving longwall pillar design. Its goal is to provide longwall operators with practical procedures for maintaining longwall ground control. The report focuses on the Analysis of Longwall Pillar Stability (ALPS) design method, which was developed largely by Bureau researchers. With ALPS, mining engineers can estimate the strength of longwall pillar systems and the load that will be applied to them. Several other methods that can be directly used to size longwall pillars are also described. The design methods are evaluated using a data bank of more than 100 mining case histories, and suggestions are given for using the methods in practical design. A step-by-step solution to a sample problem using ALPS is provided. The report also discusses the theory and practice of yield pillar design and suggests strategies for special conditions, including soft floor, excessive horizontal stresses, and multiple-seam interactions.

40335 (PB–90-225871/XAB) **Field verification of load-transfer mechanics of fully grouted roof bolts. Report of Investigations/1990.** Signer, S.P. Bureau of Mines, Spokane, WA (USA). Spokane Research Center. 1990. 21p. (BUMINES-RI–9301). Available from NTIS, PC A03/MF A01.

Library of Congress catalog card No. 89-28513.

The Bureau of Mines conducted a series of field tests to improve the understanding of the support interaction mechanics between fully grouted bolts and coal mine roofs and to help lay the foundation for improved design and evaluation techniques. Strain gauges were installed on 14 fully grouted bolts placed in shale roof rock at four mines in Colorado, Illinois, and Pennsylvania to determine how load was transferred between the bolts and the rock. The results of field tests on elastic bolt behavior compared well with previous laboratory work and numerical models. The field tests showed that the anchorage length of grouted bolts installed in shale was slightly longer than the anchorage length determined in laboratory tests conducted in concrete blocks. The field results produced more variability because of geological variations. Tests run past the yield point of the steel bolt indicate that the yield zone varies significantly and translates down the length of the bolt anywhere from 4 to 22 in.

0130 Transport, Handling, and Storage

40336 (ANL/EAIS/TM–13) **Alternative and innovative transport modes for moving US steam-coal exports to the Asian Pacific Basin.** Szpunar, C.B.; Kenkeremath, L.D.; Traczyk, P.A.; Brolick, H.J.; Heller, J.N.; Uttmark, G.F. Argonne National Lab., IL (USA). Environmental Assessment and Information Sciences Div. Nov 1989. 184p. Sponsored by U.S. DOE Fossil Energy. DOE Contract W-31109-ENG-38. Order Number DE90013537. Available from NTIS, PC A10/MF A01 - OSTI; GPO Dep.

The United States is well positioned to play an expanding role in meeting the energy demands of the Asian Pacific Basin (APB). US coal reserves, among the world's largest, contain vast amounts of surface-mineable coal in the West in addition to significant volumes in the Midwest and East. However, high inland-transportation costs and the relatively low calorific value of some Western coals have recently resulted in delivered prices exceeding those of the world market – maintaining the United States as a marginal supplier in a market that now receives one-third of worldwide steam-coal exports. This study describes alternatives that might reduce these delivered costs, emphasizing transport modes for four regions and mentioning blending for a fifth: (1) subbituminous coals of the Powder River Basin (Wyoming and Montana), (2) bituminous coals of central Utah and Colorado, (3) bituminous and subbituminous coals of the Four Corners Region (where Utah, Colorado, New Mexico, and Arizona meet), (4) bituminous and subbituminous coals of Alaska, and (5) bituminous coals of the Illinois Basin (Illinois, Indiana, and western Kentucky). It investigates innovative rail and ocean transport modes, coal-slurry pipelines, coal blends, and unconventional transport modes like overland conveyors and intermodal containers. It compares delivered prices under various scenarios, combining different transportation alternatives. 142 refs., 28 figs., 38 tabs.

0140 Combustion

Refer also to citation(s) 40272, 40281, 40317, 40349

40337 (CRIE-W–89004) **Coal ash properties formed by pulverized coal combustion.: Investigation on coal ash produced from test furnance of coal combustion.** Makino, H.; Nishida, S.; Kimoto, M.; Tanaka, T.; Inoue, T.; Ogawa, K. Central Research Inst. of Electric Power Industry, Tokyo (Japan). Sep 1989. 45p. (In Japanese). Order Number DE90507870. Available from NTIS (US Sales Only), PC A03/MF A01.

In this report, the results of the investigation made by using a test furnace of coal combustion on the influences of combustion condition and coal properties to coal ash properties are summarized. Seven kinds of coals having typical properties were selected. The unburned carbon concentration in coal ash increases with the increase of nitrogen oxides reduction rate at the low nitrogen oxides combustion condition. The mean diameter of coal ash is about 60-80 percent of the coal ash diameter calculated from the pulverized coal properties (ash content and mean diameter), and increases at the low-nitrogen oxides combustion condition. The sphere particle content of the coal ash made of the low melting point coal is very high, and decreases with the increase of nitrogen oxides reduction rate. The authors concludes that a guiding principle on the selection of test coal kinds and combustion conditions to obtain suitable coal ash for efficient use, such as manufacture of artificial light weight aggregate, etc., was acquired. 5 refs., 38 figs., 5 tabs.

40338 (DOE/FE–0195P) **Clean Coal Technology Demonstration Program: Annual report to Congress (as of December 31, 1989).** USDOE Assistant Secretary for Fossil Energy, Washington, DC (USA). Mar 1990. 266p. Sponsored by U.S. DOE Fossil Energy. Order Number DE90013603. Available from NTIS, PC A12/MF A01 - OSTI; GPO Dep.

This report describes the clean coal technology program. Environmental considerations and conversion technologies are discussed. (CBS)

40339 (DOE/MC/10637–2819) **Low-rank coal research: Quarterly report, July 1989–September 1989.** North Dakota Univ., Grand Forks, ND (USA). Energy and Mineral Research Center. [1989]. 380p. Sponsored by U.S. DOE Fossil Energy. DOE Contract FC21-86MC10637. Order Number DE90014628. Available from NTIS, PC A17/MF A01 - OSTI; GPO Dep.

Research programs on coal conversion processes, science, and waste management, from the University of North Dakota, are presented. Topics include: flue gas cleanup, waste management, regional energy policy program for the northern Great Plains, turbine combustion phenomena, combustion inorganic transformation, liquefaction reactivity of low-rank coals, gasification ash and slag characterization, coal science, fluidized bed combustion, beneficiation of low-rank coals, combustion characterization of low- rank coal fuels, diesel utilization of low-rank coals, produce and characterize HWD fuels for heat engine applications, low-rank coal direct liquefaction, production of hydrogen and by-products from coals, and chemistry of sulfur removal in mild gas.

40340 (DOE/MC/24207–2855) **Fluidized bed pressure probes.** West Virginia Univ., Morgantown, WV (USA). Dept. of Mechanical and Aerospace Engineering; West Virginia Univ., Morgantown, WV (USA). Dept. of Chemical Engineering. Apr 1990. 176p. Sponsored by U.S. DOE Fossil Energy. DOE Contract FC21-87MC24207. Order Number DE90009666. Available from NTIS, PC A09/MF A01 - OSTI; GPO Dep.

Detailed information on local fluid bed behavior cannot be obtained using global instrumentation. However, dual static pressure probes (DSPP) which measure local axial differential pressures can be used to infer the presence of bubbles or slugs in a fluid bed. DSPP consist of two probe stems, one positioned vertically above the other, connected to a differential pressure transducer. Response of DSPP has been modeled and is fast enough to capture transient phenomena in a fluid bed provided a low dead volume transducer is used. DSPP with 0.5 inch, 0.75 inch and 1 inch stem spacings have been used to measure slugging properties of a 5.5 inch diameter air-fluidized bed filled with 0.125 inch nylon spheres. Over 500 20 second pressure traces were digitally recorded for two distributor types a variety of bed heights, air flowrates and probe positions. Slugging frequency was found from the traces using the autocorrelation function, Fourier transform and spectral density function, and was shown to decrease with bed height. Slug velocity was found using cross-correlation of signals from two DSPP, and was shown to increase with air throughput. In addition, analysis was performed to show that a distribution of bubble sizes in a fluid bed can be inferred from a distribution of chord lengths found using a probe, and pressure fields around bubble pairs were modeled. The research showed that DSPP can be used successfully to measure local phenomena in fluid beds. 27 refs., 88 figs., 4 tabs.

40341 (DOE/PC/60422–T7) **Advanced slagging coal combustion system ASCCS: Final report, Volume 1, Test task results.** TRW Space and Technology Group, Redondo Beach, CA (USA). Applied Technology Div. Jun 1989. 230p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC22-84PC60422. Order Number DE90013316. Available from NTIS, PC A11/MF A01 - OSTI.

TRW has developed an advanced slagging coal combustor for the conversion to coal of coal-, oil-, and gas-fired boilers, furnaces, kilns, and other heat utilization equipment. A partially developed, slagging combustor was characterized at a thermal power level of 10 MM Btu/hr with Eastern and Western pulverized coals, and an Eastern coal water mixture. Scaling and Performance verification testing was performed on a full scale 50 MM Btu/hr combustor. The TRW 50 MM Btu/hr combustor was then mated with a TRW supplied boiler simulator to investigate combustor interaction effects with downstream heat utilization equipment. This final technical project report presents the results of a three year effort to develop a data base for coal conversions. Significant contributions have been made in coal mineral matter removal (90%+), NO_x control through combined fuel and oxidizer staging (to 250 ppMv), and characterization of the combustor particulate effluent (4 micron mean diameter, 5% above 10 microns). Fair SO_x control was achieved at the 30% to 40% reduction level. The ability to use coal water mixtures as a fuel delivery option was met with limited success. 72 figs., 5 tabs.

40342 (DOE/PC/79660–T4) **Design and test of a 0.15 MB/H vortex combustor firing DUC [dry ultrafine coal] and CWF [coal water fuel].** Fu, Tim T. (Naval Civil Engineering Lab., Port Hueneme, CA (USA)); Nieh, Sen. Naval Civil Engineering Lab., Port Hueneme, CA (USA); Catholic Univ. of America, Washington, DC (USA). Combustion and Multiphase Flows Lab. Jun 1989. 44p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AI22-87PC79660. Order Number DE90009023. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Testing of a 0.15 MB/H (0.15×10^6 Btu/hr) exploratory vortex combustor (VC) has been conducted firing either dry ultra- fine coal (DUC) or its water slurries, coal water fuel (CWF). The purpose of the present tests are twofold: to explore the technical and operational characteristics of this model, and to establish a preliminary data base for design improvement and for scaling up to a 2–4 MB/H proof-of-concept vortex combustor. The vortex combustion concept was refined and first time reduced into practice in a small hot test model in the present study. This model has been satisfactorily operated and tested for over 150 hours with DUC and CWF. Stable ignition and self-sustained combustion could be easily achieved without the need of preheating the combustion air or CWF. Supplementary fuel was not needed except possible during the startup. This report discusses in detail the overall test system, test procedures, and results on thermal, combustion, operational, and pollution performance of the VC. 13 refs., 11 figs., 4 tabs.

40343 (DOE/PC/79661–T3) **Development of a vortexing combustor (VC) for space/water heating applications (cold flow modeling): Technical progress report No. 5.** Nieh, S. Catholic Univ. of America, Washington, DC (USA). Dept. of Mechanical Engineering. Aug 1988. 35p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC22-87PC79661. Order Number DE90014601. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

A series of measurements of the gas flow field was conducted on the full-scale Vortex Combustor (VC) model. A number of influencing factors, both configurational and operational, were studied and their effects on the aerodynamic structure in the VC test chamber were delineated. Test results showed that aerodynamics

favorable for the initiation of fuel ignition and char burnout can be achieved in VC chambers. Visualization tests of particle flow on the bench-scale model demonstrated that particle behaviors in the VC chamber can be controlled aerodynamically. The test results and operational experience are deemed highly valuable for VC combustor design. In the aspect of mathematical modeling, computations of the particle flow field with the newly developed statistic-trajectory model have been made based on solved gas flow field in VC processes. The interaction of gas flow field and particle flow field in terms of gas-particle slip velocity was identified. Large gas-particle slip velocities obtained in the VC chamber are highly favorable for the combustion processes. 5 refs., 16 figs., 4 tabs.

40344 (DOE/PC/90751–T4-Pt.1) **Transformations of inorganic coal constituents in combustion systems: Part 1, Sections 1 through 6: Phase 1 final report, October 25, 1986–December 29, 1989 including quarterly report No. 13, October–December 29, 1989.** Boni, A.A. (PSI Technology Co., Andover, MA (USA)); Helble, J.J.; Srinivasachar, S.; Beer, J.M.; Sarofim, A.F.; Bryers, R.W.; Flagan, R.C.; Huffman, G.P.; Huggins, F.E.; Peterson, T.W. PSI Technology Co., Andover, MA (USA). Mar 1990. 508p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC22-86PC90751. (PSI–1024/TR-1010-Pt.1). Order Number DE90014467. Available from NTIS, PC A22/MF A01 - OSTI; GPO Dep.

Objectives of this project are to: define the partitioning of inorganic constituents associated with raw coal particles among products (including vapors, aerosols, and residual char/ash particles) formed under conditions representative of pulverized coal flames as a function of the specific (intrinsic and extrinsic) characteristics of the raw coal and the environment in which the transformations occur; elucidate and quantify the fundamental processes by which transformations of the inorganic constituents occur; and develop, based on the information required in the above, a tractable "process" model capable of predicting the significant features of the transformation process, most importantly, the distribution and nature of products. Research tasks include: coal selection, preparation, and characterization; characterization by advanced analytical techniques; and fundamental studies of ash vaporization and aerosol dynamics. References, figures and tables are included in each task.

40345 (DOE/PC/90751–T4-Pt.2) **Transformations of inorganic coal constituents in combustion systems: Part 2, Sections 7 and 8; Appendices A and B: Phase 1 final report, October 25, 1986–December 29, 1989 including quarterly report No. 13, October–December 29, 1989.** Boni, A.A. (PSI Technology Co., Andover, MA (USA)); Helble, J.J.; Srinivasachar, S.; Beer, J.M.; Sarofim, A.F.; Bryers, R.W.; Flagan, R.C.; Huffman, G.P.; Huggins, F.E.; Peterson, T.W. PSI Technology Co., Andover, MA (USA). Mar 1990. 492p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC22-86PC90751. (PSI–1024/TR-1010-Pt.2). Order Number DE90014468. Available from NTIS, PC A21/MF A01 - OSTI; GPO Dep.

Objectives of this project are to: define the partitioning of inorganic constitutents associated with raw coal particles among products (including vapors, aerosols, and residual char/ash particles) formed under conditions representative of pulverized coal flames as a function of the specific (intrinsic and extrinsic) characteristics of the raw coal and the environment in which the transformations occur; elucidate and quantify the fundamental processes by which transformations of the inorganic constituents occur; and develop, based on the information required above, a tractable "process" model capable of predicting the significant features of the transformation process, most importantly, the distribution and nature of products. This report describes work in the following areas: behavior and effects of coal mineral matter in a laboratory pulverized coal combustor, and idealized combustion determination of ash particle formation and surface stickiness.

40346 (ECN–225) **Early reactivity and nitrogen release in pulverized coal combustion: Investigation within the project 'Initial Stages of Combustion' of the International Energy Agency implementing agreement for a program of research, development and demonstration of coal combustion sciences, Annex 1.** Ten Brink, H.M.; Heere, P.G.T. Netherlands Energy Research Foundation, Petten (Netherlands). Jan 1990. 61p. Contract NOVEM 0435. Order Number DE90797095. Available from NTIS (US Sales Only), PC A04/MF A01.

The extent and rate of the release of volatile combustibles from pulverized high-volatile bituminous coals has been tested as a means to characterize the early reactivity. These tests were performed on a set of coals in a bench-scale laminar flow burner, in which temperature and heating rate are representative of those in a full-sized furnace flame. Results were compared with those obtained in fixed-bed tests. In conjuction with the probing of the reactivity of the coals in the initial combusition phase, the rate and extent of the early nitrogen release of the coals were determined. The objective of the tests is to evaluate the usefullness of laminar flow burners as a test facility for assessing early combustion characteristics. 9 tabs., 5 figs., 22 refs., 2 apps.

40347 (EUR–11793) **6-MW_{th} atmospheric fluidized bed combustion plant Koenig Ludwig. Demonstration project.** Commission of the European Communities, Luxembourg (Luxembourg). 1988. 51p. Contract CS/180/83;CS/21/84. Available from NTIS (US Sales Only), PC A04/MF A01.

The aim of the demonstration project was to adapt and operate an existing 6MW steam boiler with integrated fluidized bed firing so that a wide range of fuels could be burnt in an environmentally acceptable manner with fully automatic operation of the plant. This aim was achieved. The boiler was operated for 15 500 hours during the project. The fuels included high and low volatile coals of up to 30 mm in size with ash contents from 4 to 45%, coal-water suspensions containing more than 70% solids, hydrogenation residues and pitch and, mixed with coal, refuse briquettes and spent coke oven gas cleaning residues containing more than 30% sulphur. The desired fuel flexibility and the possibility of reducing operating costs by completely automatic operation were demonstrated. It was also shown that coal could be as convenient for the user as oil or gas. Tests were carried out to display the sulphur-retaining potential of various limestones available on the market. Experience gained from plant operation led to the installation of air staging which made it possible, in particular, to meet, over a wide range of operating conditions, the increasingly severe limits for NO_x emissions. It was possible to demonstrate possibilities for utilizing the fly ash produced. The leaching properties of FBC ash were studied by means of long-term lysimeter tests, and the results were compared to those obtained by standard methods. All the emission limits prescribed by TA-Luft 86 were met, and emissions were in some cases well below the required values. Special measurements of emissions of hydrocarbons, polycyclic aromatic hydrocarbons and trace elements in the waste gases gave results that were significantly below the TA-Luft 86 limit values, and were at the limit of detectability in certain cases.

40348 (ORNL/FTR–3664) **[Materials and thermodynamic cycles of coal conversion processes]: Foreign trip report, June 2, 1990–June 20, 1990.** Judkins, R.R. Oak Ridge National Lab., TN (USA). 3 Jul 1990. 27p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC05-84OR21400. Order Number DE90013393. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The purpose of this trip was to learn about English government-funded work on coal conversion and utilization processes, particularly the topping cycle system employing coal gasification and circulating fluidized-bed combustion; to discuss Dutch University research on recovery and storage of carbon dioxide; to discuss fossil energy materials research and development activities at the Netherlands Organization for Applied Scientific Research (TNO); and to chair an ASME Coal Utilization Committee session on Coal-Based Gas Turbine Systems at the 35th International Gas Turbine and Aeroengine Congress and Exposition (ASME Congress). Visits were made to the British Coal Corporation Coal Research Establishment (CRE) in England, and to the University of Utrecht and the TNO Metals Research Institute in The Netherlands. Mutual areas of research interest were discussed with CRE including a project for testing iron aluminide alloys in the CRE gasifier. Agreement was reached on cooperation in regard to exchange of information on ceramic filter development, and it was decided to continue discussions for testing filters fabricated on the AR&TD Materials

Program in CRE's Filter Durability Test Program. Extensive discussions at the University of Utrecht centered on their studies of the technologies and costs of removing and sequestering carbon dioxide emissions from fossil-fired power plants. Research areas of mutual interest were discussed at the TNO Metals Research Institute, particularly their work on materials for fluidized-bed combustion systems. At the ASME Congress, the principal activity was the conduct of a session on coal-based gas turbine systems.

0150 Economic, Industrial, and Business Aspects

40349 (CONF-900734–1) **Applying clean coal technologies in the Asian Pacific Basin.** Gillette, J.L.; Szpunar, C.B.; Surles, T.G. Argonne National Lab., IL (USA). [1990]. 19p. Sponsored by U.S. DOE Fossil Energy. DOE Contract W-31109-ENG-38. From 5. Pacific Rim coal conference; Denver, CO (USA); 22-25 Jul 1990. Order Number DE90013654. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The United States is well positioned to play an expanding role in meeting the energy-technology demands of the Asian Pacific Basin (APB). The US Clean Coal Technology (CCT) Demonstration Program, spearheaded, stewarded, and managed by the US Department of Energy in full partnership with US industry, provides a proving ground for innovative coal-related technologies. Its precombustion, combustion, postcombustion, and conversion technologies, once tested and proven at the demonstration level, are expected to be applicable to coal-burning facilities in the APB (and elsewhere), in both the utility and industrial sectors. These technologies and concepts are expected to allow for increased utilization of the vast coal and lignite resources in the APB in an efficient, economic, and environmentally acceptable manner. They also could provide the opportunity for increased sales of US coals. Specific, potential applications in the APB will be presented, highlighting possibilities in Indonesia, Japan, the Peoples' Republic of China, South Korea, Taiwan, and Thailand. 4 refs., 1 tab.

40350 (UCID–19227-89) **US energy flow–1989.** Borg, I.Y.; Briggs, C.K. Lawrence Livermore National Lab., CA (USA). Jun 1990. 15p. Sponsored by U.S. DOE Fossil Energy. DOE Contract W-7405-ENG-48. Order Number DE90014721. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Energy consumption in 1989 closely resembled that in 1988 although a modest increase of less than 2% was indicated by preliminary data. After steady increases for almost a decade, energy used in the transportation sector stabilized. Oil imports rose 57% over those in 1982 and constituted 41% of total supply. By year-end domestic crude oil production fell to 1964 levels. Coal production set records with the bulk of it dedicated to electrical production. Natural gas consumption remained near that of 1988; however imports from Canada played a larger role in supply. High rates of growth in electrical consumption associated with the last decade were not sustained in 1989. Nuclear power reactors contributed 19% to total supply, a percent that is expected to fall as new non-nuclear power sources come on line in response to anticipated continued growth in demand. 18 refs., 6 figs., 2 tabs.

0160 Health and Safety

40351 (PB–90-215971/XAB) **Assessing indoor-air-pollution exposure and lung-cancer risk in Xuan Wei, China.** Chapman, R.S.; Mumford, J.L.; He, X.; Harris, D.B.; Yang, R. Environmental Protection Agency, Research Triangle Park, NC (USA). ©1989. 10p. (EPA–600/J-89/362). Available from NTIS, PC A02/MF A01.

Pub. in Jnl. of the American College of Toxicology, Vol. 8, No. 5, 941-948(1989).

The report presents risk assessment-related aspects of a multidisciplinary study of indoor coal smoke pollution and lung cancer in Xuan Wei County, Yunnan Province, China. Xuan Wei presents a unique natural experiment in environmental carcinogenesis because lung cancer mortality rates and indoor pollution exposures vary widely within the County. Current evidence links lung cancer with domestic burning of 'smoky coal,' as opposed to 'smokeless coal' and wood. Efforts to determine the most carcinogenic components of smoky coal pollution are in progress, as are efforts to develop a quantitative relationship of pollution dose with lung cancer response in Xuan Wei. Some available evidence suggests that the composition of indoor pollution does not vary greatly throughout Xuan Wei, and thus that lung cancer risk is a function of overall pollution exposure. Other evidence suggests that different Xuan Wei fuels exhibit different carcinogenic potencies. On-site and laboratory studies are being conducted to distinguish between these possibilities.

40352 (PB–90-217506/XAB) **Mouse skin tumorigenicity studies of indoor coal and wood combustion emissions from homes of residents in Xuan Wei, China with high lung cancer mortality.** Mumford, J.L.; Helmes, C.T.; Lee, X.; Seidenberg, J.; Nesnow, S. Environmental Protection Agency, Research Triangle Park, NC (USA). Health Effects Research Lab. ©1990. 9p. (EPA–600/J-90/045). Available from NTIS, PC A02/MF A01.

Pub. in Carcinogenesis, Vol. 11, No. 3, 397-403(Mar 1990).

The rural Xuan Wei County, Yunnan Province, China, has an unusually high lung cancer mortality rate that cannot be attributed to tobacco smoke or occupational exposure. The lung cancer rate is associated with 'smoky' coal, in contrast to wood or 'smokeless' coal burned in unventilated homes. The study was conducted to characterize and compare mouse skin tumorigenicity of the coal and the wood combustion emissions and to link the resulting animal data to human lung cancer. Indoor air particles were collected from a central commune where the lung cancer mortality rate is high and smoky coal is the major fuel used, and also from a south western commune where lung cancer mortality rate is low and wood and smokeless coal are the major fuels used. The organic extracts of these indoor air particles were analyzed for polycyclic aromatic hydrocarbons (PAHs) and assayed for skin tumor initiation activity and complete carcinogenicity in SENCAR mice. Mouse skin was initiated with 1,2,5,10, and 20 mg of organic extracts of the emission particles during the first week, and one week after initiation the mice were promoted with 12-0-tetradecanoylphorbol-13-acetate (TPA, 2 microgram/mouse) applied topically twice a week for 26 weeks. The results showed that the smoky coal sample is the most active among the three combustion emission samples.

40353 (PB–90-222464/XAB) **Effects of selected physical agents on the performance of acoustically absorptive materials. Report of Investigations/1990.** Burks, J.A.; Ruhe, T.C.; Spencer, E.R. Bureau of Mines, Pittsburgh, PA (USA). Pittsburgh Research Center. 1989. 41p. (BUMINES-RI–9298). Available from NTIS, PC A03/MF A01.

Library of Congress catalog card No. 89-600321.

When acoustical materials are used in a mining environment for noise control purposes, they are subject to environmental deterioration from hydraulic fluid, moisture, and dust. These and other factors can cause physical degradation of the material, which can lessen its ability to absorb sound. In the study, the Bureau of Mines measured the sound absorption properties of 16 different acoustical materials after 4 sample treatments: (1) being kept clean and dry (as received from the supplier), as a control or reference standard, (2) immersion in water and draining, (3) immersion in 100-pct-petroleum-type hydraulic fluid and draining, and (4) exposure in a coal mine. The last three treatments were used to approximate the type of physical degradation that can be experienced in actual use. The impedance tube or standing wave method was used to measure the normal absorption coefficient. It was found that the absorption coefficient of most materials was adversely affected by the retention of either oil or water, with oil having the greater effect. The only class of materials that was affected by neither oil nor water was neoprene foam.

40354 (PB–90-871278/XAB) **Mine safety: Fires and explosions. January 1970-September 1987 (A Bibliography from the NTIS data base). Report for January 1970-September 1987.** National Technical Information Service, Springfield, VA (USA). Jun 1990. 176p. Available from NTISPC N01/MF N01.

See also PB–90-871286.

This bibliography contains citations concerning preventative measures and processes pertaining to mine fires in dust and gaseous atmospheres. Topics include fire protection systems, detection and warning systems, descriptions of explosion-proof enclosures, and mathematical models of mine combustion processes. Mobile and

stationary equipment, and combustion characteristics of specific materials used in mining operations are also discussed. (This updated bibliography contains 374 citations, none of which are new entries to the previous edition.)

40355 (PB–90-871286/XAB) **Mine safety: Fires and explosions. October 1967-May 1990 (A Bibliography from the NTIS data base). Report for October 1967-May 1990.** National Technical Information Service, Springfield, VA (USA). Jun 1990. 45p. Available from NTISPC N01/MF N01.

Supersedes PB–87-867073. See also PB–90-871278.

This bibliography contains citations concerning preventative measures and processes pertaining to mine fires in dust and gaseous atmospheres. Topics include fire protection systems, detection and warning systems, descriptions of explosion-proof enclosures, and mathematical models of mine combustion processes. Mobile and stationary equipment, and combustion characteristics of specific materials used in mining operations are also discussed. (This updated bibliography contains 64 citations, all of which are new entries to the previous edition.)

02 PETROLEUM

0202 Reserves, Geology, and Exploration

Refer also to citation(s) 41754

40356 (DOE/BC/14425–T4) **Establishment of an oil and gas database for increased recovery and characterization of oil and gas carbonate reservoir heterogeneity: Technical progress report, April 1, 1990–June 30, 1990.** Mancini, E.A. Geological Survey, Tuscaloosa, AL (USA). [1990]. 5p. Sponsored by U.S. DOE Fossil Energy. DOE Contract FG22-89BC14425. Order Number DE90014379. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The objective of this project is to augment the National Reservoir Database (TORIS database) and to increase our understanding of geologic heterogeneities that effect the recoveries of oil and gas from carbonate reservoirs in the State of Alabama and to identify those resources that are producible at moderate cost. This objective will be achieved through detailed geological, geostatistical, or engineering characterization of typical Jurassic Smackover Formation hydrocarbon reservoirs in selected productive fields in the State of Alabama. The results of these studies will be used to develop and test mathematical models for prediction of the effects of reservoir heterogeneities in hydrocarbon production.

40357 (DOE/FE–0165P-1) **Strategic Petroleum Reserve quarterly report.** USDOE Assistant Secretary for Fossil Energy, Washington, DC (USA). Office of Petroleum Reserves. 15 May 1990. 10p. Sponsored by U.S. DOE Fossil Energy. Order Number DE90013638. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The Strategic Petroleum Reserve (SPR) was created to reduce the impact of disruptions in petroleum supplies and to carry out obligations of the United States under the Agreement on an International Energy Program. This May 15, 1990, Strategic Petroleum Reserve Quarterly Report describes activities related to the site development, oil acquisition, budget and cost of the Reserve during the period January 1, 1990 through March 31, 1990. 3 tabs.

40358 (LA-UR–90-1514) **Microseismic monitoring of the Chaveroo oil field, New Mexico.** Rutledge, J.T.; Albright, J.N.; Fairbanks, T.D.; Murphy, M.B.; Roberts, P.M. Los Alamos National Lab., NM (USA). [1990]. 10p. Sponsored by U.S. DOE Fossil Energy. DOE Contract W-7405-ENG-36. (CONF-900907–2: Annual meeting of the Society of Exploration Geophysicists, San Francisco, CA (USA), 23-27 Sep 1990). Order Number DE90012100. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Induced microseismicity was monitored in the Chaveroo oil field in southeastern New Mexico during a pressurized stimulation of a well being prepared as an injector for a waterflood operation. In addition, the microseismicity was monitored for 5 weeks following the stimulation while the area was under normal waterflood production. Little seismicity was detected during the 5.5 hour stimulation in which three thousand barrels of water were injected into the reservoir at pressures ranging from 96 to 257 bars in excess of hydrostatic pressure. Intermittent monitoring over the 5-week period indicated detectable seismicity occurred during waterflood production. Monitoring during the 5 weeks, however, was not complete enough to draw general conclusions on temporal variations of observed microseismicity. Seventy-three good quality events recorded over a cumulative 24 hours of intermittent monitoring were located using the hodogram technique. Events were detected at distances up to 1700 m from the monitor well but most occurred within 900 m. The map of microearthquake locations indicated that events occurred in the vicinity of producing wells and away from injection wells. The first half of the sequence of mappable events occurred along linear trends, but the pattern became more scattered during the later half of the sequence. The lack of seismicity during the pressurized injection and the increased seismicity levels occurring away from injection wells during waterflood production, suggest seismicity is not induced by Mohr-Coulomb failure. 6 refs., 6 figs.

0203 Drilling and Production

40359 (DOE/BC–89/4) **Contracts for field projects and supporting research on enhanced oil recovery: Progress review No. 60 quarter ending September 30, 1989.** USDOE Assistant Secretary for Fossil Energy, Washington, DC (USA). Office of Oil, Gas and Shale Technology; USDOE Bartlesville Project Office, OK (USA). Jun 1990. 109p. Sponsored by U.S. DOE Fossil Energy. Order Number DE90000219. Available from NTIS, PC A06/MF A01 - OSTI; GPO Dep.

Research programs on enhanced petroleum recovery are briefly described. References are included with each program description. (CBS)

40360 (OCS/MMS–90-0015) **Oil and gas leasing/production program: Annual report/FY 1989.** Minerals Management Service, Herndon, VA (USA). Office of Offshore Information and Publications. 31 Mar 1990. 55p. Sponsored by U.S. Department of the Interior. Available from OSTI; Office of Offshore Information and Publications, Minerals Mgt. Serv., MS-642, 381 Elden St., Herndon, VA 22070-4817.

As the Congress declares in the Outer Continental Shelf Lands Act (OCSLA), the oil and gas production from the outer Continental Shelf (OCS) constitutes an important part of the Nation's domestic energy supply. (See Introduction, page 1.) The OCS is administered within the Department of the Interior, by the Minerals Management Service (MMS), which provides access to potential new sources of oil and gas offshore by conducting lease sales. (See MMS Organizational Chart.) Each year, on or before March 31, the MMS as mandated by OCSLA, presents to Congress a fiscal year annual report on the OCS oil and gas leasing and production program. In FY 1989, the MMS with its OCS oil and gas leasing and production program was the fourth largest producer of revenue for the US treasury at more than $2.9 billion. This report summarizes the leasing and production activities on the OCS during FY 1989. 11 figs., 10 tabs.

0204 Processing

Refer also to citation(s) 41138

0207 Economic, Industrial, and Business Aspects

Refer also to citation(s) 40350

40361 (AD-A–220645/6/XAB) **Mexican oil: Its history, development and future. Study project.** Koller, R. Army War Coll., Carlisle Barracks, PA (USA). 2 Apr 1990. 89p. Available from NTIS, PC A05/MF A01.

Oil has been an important resource in the modernization of Mexico. Most of Mexican economic development since petroleum nationalization has been based on this strategic source of energy by means of exploitation and exportation. Postrevolutionary governments have relied primarily on petroleum to accomplish the

political, social and economic aims set forth in the Constitution of 1917. Oil revenues have allowed Mexican governments to pursue domestic political, social and economic goals and also ambitious foreign political and economic policies. This paper begins by describing the history of Mexican oil, focusing mainly on analyzing problems, goals achieved, development and oil policies since the oil nationalization in 1938 by General Lazaro Cardenas. Facts and policies related to the boom and crisis of the 1970's, 1980's are also analyzed as are efforts made in the 1980's, 1990's to save the country from the economic crisis. Current oil policies are reviewed and conclusions given.

0209 Environmental Aspects

40362 (AD-A-220718/1/XAB) **Biodegradation of hydrocarbons as a remediation method for petroleum contaminants in the environment or as a treatment method for petroleum wastes (a review and analysis of recent field study literature). Master's thesis.** Lubbers, J.E. Kansas Univ., Lawrence, KS (USA). Dept. of Chemical and Petroleum Engineering. Dec 1989. 121p. Available from NTIS, PC A06/MF A01.

The U.S. Navy Petroleum Office (NAVPETOFF) is developing future Navy petroleum sludge disposal and soil decontamination procedures. This project was conducted for NAVPETOFF to aid that development by evaluating the use of bacteria to eliminate petroleum hydrocarbons as a disposal or decontamination option. Electronic data base searchers, interviews with bioremediation researchers, and manual literature searches were conducted to collect information about microbial bioremediation from sources which postdate the 1984 amendments to RCRA. From that body of information, reports of field applications of microbial bioremediation on petroleum wastes or contaminants were set apart as the primary references for evaluation development. summaries of reported microbial bioremediation methods were developed are presented. These summaries are introduced by a review of the biologic limits and processes of the microbes commonly used for bioremediation. The body of these summaries describes and illustrates their techniques. Each summary concludes with an evaluation in the form of a report of the method's effectiveness.

40363 (PB-90-216466/XAB) **Alaskan oil spill bioremediation project.** Eastern Research Group, Inc., Arlington, MA (USA). Aug 1989. 20p. Available from NTIS, PC A03/MF A01.

Color illustrations reproduced in black and white.

The U.S. Environmental Protection Agency's Office of Research and Development entered into a cooperative agreement with the Exxon Company to initiate a bio-remediation study as part of an effort to clean up oil on the shorelines of Prince William Sound, Alaska. The presence of oil was the result of an 11-million gallon spill of crude oil from the tanker, Exxon Valdez, on March 24, 1989. The study was designed to determine the feasibility of using nutrients to enhance microorganisms that live in the waters and sediments to degrade the oil and, thus, reduce its detrimental effects. Two types of fertilizer, a water soluble and an oleophilic, were applied on both physically cleaned and untreated beach sediments. Several sampling and field testing methods were used to observe changes in the composition of the oil, to monitor the movement of added nutrients in the test beaches, to detect changes in the number of bacteria present as the test proceeded and to assess the degradation of the oil. Based on available results of ORD's research, Exxon proposed to begin bioremediation on nearly 6,000 yards of shoreline in the Sound. The application began August 1, 1989.

40364 (PB-90-219973/XAB) **Coping with an oiled sea: An analysis of oil-spill-response technologies.** Office of Technology Assessment (U.S. Congress), Washington, DC (USA). Mar 1990. 82p. (OTA-BP-O-63). Available from NTIS, PC A05/MF A01.

Also available from Supt. of Docs.

Current national capabilities to respond effectively to such an accident are marginal at best. OTA's analysis shows that improvements could be made, and that those offering the greatest benefits would not require technological breakthroughs-just good engineering design and testing, skilled maintenance and training, timely access to and availability of the most appropriate and substantial systems, and the means to make rapid, informed decisions.

0210 Legislation and Regulations

40365 (PB-90-213612/XAB) **Land use planning and oil and gas leasing on onshore federal lands. Final report.** National Academy of Sciences, Washington, DC (USA). Commission on Physical Sciences, Mathematics, and Resources. Nov 1989. 172p. Available from NTIS, PC A08/MF A01.

Library of Congress catalog card no. 89-63529.

The Federal Onshore Oil and Gas Leasing Reform Act of 1987 required a study by the Comptroller General of the United States and the National Academy of Sciences to recommend any improvements that may be necessary to insure that potential oil and gas resources are adequately addressed in planning documents; the social, economic, and environmental consequences of exploration and development of oil and gas resources are determined; and any stipulations to be applied to oil and gas leases are clearly identified. The report identifies problems in land use planning that are caused by current leasing practices and the availability and reliability of information at the planning stage. The recommendations address the interrelation between oil and gas leasing decisions and the land use planning process for the federal lands.

0220 Transport, Handling, and Storage

Refer also to citation(s) 40357, 40368, 40998

40366 (PB-90-869181/XAB) **Concrete storage tanks: Design and construction. January 1970-March 1990 (A Bibliography from the COMPENDEX data base). Report for January 1970-March 1990.** National Technical Information Service, Springfield, VA (USA). May 1990. 69p. Available from NTISPC N01/MF N01.

This bibliography contains citations concerning reinforced concrete for high-rise, above ground, and underground storage tanks. Topics include tank construction, design criteria for tanks, prestressed concrete, concrete repair, and concrete formulations. Applications of reinforced concrete tanks are presented; these include storage of drinking water, oils, and liquefied gases. Pressure testing, and structural analyses of concrete storage tanks are examined. (Contains 155 citations fully indexed and including a title list.)

0230 Properties and Composition

Refer also to citation(s) 40475, 40951

40367 (FRNC-TH-3576) **Contribution to the structural study of petroleum deposit fluids by nuclear magnetic resonance.** Rousseau, B. Paris-11 Univ., 91 - Orsay (France). 1987. 162p. (In French). Order Number DE90501036. Available from NTIS (US Sales Only), PC A08/MF A01.

NMR spectroscopy is used for the determination of a mean molecule representative of a petroleum fraction. Nuclear magnetic resonance of proton and carbon 13, and high resolution mass spectrometry are used to build a set of mean pseudo-molecules representing part of a particular fluid: the Alwyn fluid which comes from a North Sea deposit. Different methods of mean molecular weight measurements by NMR are compared and are also compared to high resolution mass spectrometry. 45 refs.

40368 Method and apparatus for assessing distillate-fuel stability by oxygen overpressure. Hardy, D.R.; Beal, E.J.; Burnett, J.C. To Department of the Navy, Washington, DC (US). USA Patent Application 7-371,782. 27 Jun 1989. 22p. Available from NTISPC N03/MF A01.

This Government-owned invention available for U.S. licensing and, possibly, for foreign licensing. Copy of application available NTIS.

Reactions leading to insoluble sediments formation in distillate fuel are accelerated by forcing oxygen into solution in the fuel at pressures of between about 90 and 110 psig and then stressing the fuel under conditions of accelerated storage at temperatures of

between about 40 C to 100 C. The method then makes use of gravimetric determination of the total insoubles formed. The stability of the fuel over a period of time as well as its comparitive stability to other fuels can then be predicted from the amount of insolubles formed. The method can be carried out by using a specialized pressure vessel.

03 NATURAL GAS

0302 Reserves, Geology, and Exploration

40369 (PB–90-216623/XAB) **Helium isotopic constraints on terrestrial degassing and the transcrustal transport of mantle methane. Second annual report, 1 July 1988-30 June 1989.** Torgersen, T. Connecticut Univ., Groton, CT (USA). Marine Sciences Inst. 1989. 100p. Available from NTIS, PC A05/MF A01.

The research is directed towards an evaluation of the crustal degassing process, its length- and time-scale, and its geologic and tectonic controls. The improved understanding of the crustal porefluid transport processes determined in the project will provide new insight with regard to the traditional gas resources and the techniques employed to assess their potential, their genesis and the mechanisms of their accumulation and transport to geologic traps. The accumulation of He and Ar in the Great Artesian Basin (Australia) indicate that a large crustal degassing flux dominates the accumulation of these gases in the reservoir system. These fluxes are equivalent to the whole crustal production rate from U, Th and K. The fluxes appear to be decoupled and discontinuous. The magnitude of these fluxes is confirmed with an atmospheric balance. The results of porefluid sampling and analysis at the Cajon Pass scientific drillhole indicate that the mechanisms of crustal fluid mass transport are indeed discontinuous and very rapid compared to predicted and expected Darcy flow models. The decoupling and the discontinuity of these fluxes is probably controlled by mechanical and tectonic processes although the inhomogeneity of U and Th distribution contribute significantly to an enhancement of He release over Ar release.

40370 (SAND–90-0683) **Geotechnology for tight gas reservoirs: Annual report for fiscal year 1989.** Northrop, D.A. (ed.). Sandia National Labs., Albuquerque, NM (USA). Jun 1990. 82p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC04-76DP00789. Order Number DE90013600. Available from NTIS, PC A05/MF A01 - OSTI; GPO Dep.

This annual report summarizes progress which has been made in Fiscal Year 1989 on this program of geotechnology for tight gas reservoirs. Most of the studies are an outgrowth of the results and experience from the Multiwell Experiment – an unprecedented investigation of western gas reservoirs typical of the Mesaverde Formation. Results are presented in the following study areas: (1) tectonism, subsidence and fracturing of these reservoirs, (2) mechanism for the formation of regional fractures in flat-lying basins, (3) the case against natural hydraulic fracturing, (4) characterization and implications of dickite-mineralized fractures, (5) significance of coring-induced fractures, (6) determination of an effective stress law for permeability in tight sandstones, and (7) stress azimuths for two well sites in the Piceance Basin. In addition, technology transfer aspects and impact of the Multiwell Experiment are summarized. 27 refs., 28 figs., 1 tab.

0303 Drilling, Production, and Processing

Refer also to citation(s) 40331, 40332, 40360, 40370

40371 (PB–90-216631/XAB) **Enhanced gas production through hydraulic fracturing of coal seams. Final report, January 1987-December 1988.** Carter, R.H.; Holditch, S.A.; Hinkel, J.; Jeffrey, R. Holditch (S.A.) and Associates, Inc., College Station, TX (USA). Oct 1989. 219p. Available from NTIS, PC A10/MF A02.

See also PB–89-125298.

During the past few years, research projects conducted by the Gas Research Institute have clearly shown that methane from coal seams is a gas resource that has the potential for providing large volumes of natural gas. Tax incentives have made this resource even more viable, resulting in a very high level of activity in coal seam development. With a few critical improvements in stimulation technology, large volumes of gas can be produced from coal seams at competitive prices. The most important improvements in technology that will be required to fully exploit this resource are formation evaluation and reservoir flow analysis in coal reservoirs, improved well completion techniques, and improvements in fracture treatment technology. The report presents the final results of a study to determine the optimal completion strategies, fracture fluid systems fracture propagation modeling, and hydraulic fracturing techniques needed to stimulate coal seams. Results from numerical modeling, coal fines generation laboratory studies, and dewatering laboratory studies are presented. Summaries of pressure transient tests analyses and fracture treatment design and supervision are presented. A review of the Coal Seam Stimulation Manual is also included in the report.

40372 (PB–90-216755/XAB) **Tight gas sands research program: Field operations and analysis. Cooperative well report. ARCO Oil and Gas B. F. Phillips No. 1 Chapel Hill Field Smith County, Texas, March 1985. Topical report.** Holditch, S.A.; Robinson, B.M.; Whitehead, W.S. Holditch (S.A.) and Associates, Inc., Bryan, TX (USA). Apr 1985. 170p. Available from NTIS, PC A08/MF A01.

Results are presented from an analysis of the ARCO Oil & Gas B.F. Phillips Well No. 1 which is completed in the upper Travis Peak formation in Chapel Hill Field, Smith County, Texas. The Phillips No. 1 was the first cooperative well in the GRI program which was monitored with the Mobile Testing and Control (T&C) Facility during pre-fracture and post-fracture testing, and fracture treatment. In addition to coring and logging, activities included performing an in-situ stress test in a sandstone interval, performing a mini-frac, running post fracture gamma ray and temperature surveys, and monitoring hydraulic fracture treatment. Fracture treatment summaries and the pressure buildup test analysis are included in appendixes.

0304 Products and By-Products

Refer also to citation(s) 40483

0306 Economic, Industrial, and Business Aspects

Refer also to citation(s) 40955

40373 (PB–90-216722/XAB) **Gas Research Institute 1989 annual report. Issues for the 1990s. Deliverability, environment, quality of service.** Gas Research Inst., Chicago, IL (USA). Apr 1990. 51p. (GRI–90/0105). Available from NTIS, PC A04/MF A01.

See also PB–89-195812. Color illustrations reproduced in black and white.

The GRI 1989 Annual Report discusses strategies for the future, issues for the 1990s, meeting demand, preserving the environment, and what consumers want most. The financial report is included; the Board of Directors, management, membership, advisory bodies, and 1989 contractors are listed.

40374 (PB–90-219361/XAB) **Appropriate use of climatic information in Illinois natural-gas utility weather-normalization techniques. Report of investigation.** Easterling, W.E.; Angel, J.R.; Kirsch, S.A. Illinois State Water Survey, Champaign, IL (USA). 1990. 37p. (ISWS/RI–112/90). Available from NTIS, PC A03/MF A01.

Historical climate data from 41 sites in Illinois were used to determine the optimal averaging period for predicting heating degree day accumulations up to 5 years ahead. This was done by examining all possible averaging periods between 1 and 30 years and using four different evaluation techniques. In general, an 11-year mean best predicted heating degree days 1 year ahead, while a 19-year mean performed best for predicting beyond 1 year. To illustrate the effect of using climate means with different averaging periods, a simple weather-normalization model was developed in which selected heating degree day means from historical cases were employed. The use of simulated price and sales data in the

model permitted an illustration of the relative dollar differences achieved through using contrasting climate means.

0307 Waste Management

Refer also to citation(s) 40383

0308 Environmental Aspects

Refer also to citation(s) 40955

40375 (PB–90-219296/XAB) **Global climate change: A proposed gas industry program on global climate issues.** Gas Research Inst., Chicago, IL (USA). Jan 1990. 10p. (GRI–90/0126). Available from NTIS, PC A02/MF A01.

The potential role that natural gas will play in a strategy to mitigate global climate change must be addressed by the gas industry in an aggressive research program. GRI initiated a program to study the implications of increased gas use on the global climate. The GRI program is aimed at quantifying methane emissions from the production distribution, and use of natural gas; comparing the effectiveness of methane as a greenhouse gas relative to carbon dioxide; evaluating the cost-effectiveness of available options for reducing methane emissions; and developing a database of methane emissions from the world natural gas industry.

0310 Legislation and Regulations

Refer also to citation(s) 40365

0320 Transport, Handling, and Storage

Refer also to citation(s) 40366, 40477

40376 (PB–90-216573/XAB) **Review and evaluation of long-term strength of fiberglass products for line-pipe reinforcement. Topical report, May 1989-January 1990.** Stephens, D.R. Battelle Columbus Div., Washington, DC (USA). Jan 1990. 75p. (N–0964-8300). Available from NTIS, PC A04/MF A01.

The objective of the research program is to review and evaluate technical literature and available performance data on long-term strength and creep of NCF fiberglass composite products for pipeline reinforcement, rehabilitation and repair. The program consists of a review of existing technical literature applicable to the NCF reinforcement systems, as well as a review of experience and performance data from NCF on reinforced compressed gas cylinders. An assessment is made from the information on the expected long-term strength behavior of NCF products and determination of the need for additional research on long-term strength. The results of review of available literature on performance of fiberglass products has indicated three primary aspects of fiberglass behavior that will influence long-term strength of NCF products: creep, stress rupture, and initiation of glass/resin interfacial disbonding and resin cracking.

40377 (PB–90-216763/XAB) **Transport and Storage Research Program. Gas Research Institute: Status report-1989 projects.** Gas Research Inst., Chicago, IL (USA). Mar 1990. 197p. (GRI–90/0077). Available from NTIS, PC A09/MF A02.

See also PB–89-180160.

The 1989 status report of the Gas Research Institute Transport and Storage Research Subprogram describes the tactical objectives, major accomplishments and strategies, and provides contract status reports for projects within these project areas: Construction and Maintenance, Metering and Operations, Plastic and Advanced Distribution Piping Materials, Residential/Commercial Interior Distribution Systems, Gas Storage Technology, Transmission Piping Systems, and Advanced Transport and Sensor-Based Systems.

40378 (PB–90-217332/XAB) **User's guide on butt heat-fusion joining of polyethylene gas pipes. Topical report, July 1986-September 1989. Volume 1.** Pimputkar, S.M.; Cassady, M.; McCoy, J.K.; Stets, J.A.; Uralil, F. Battelle Columbus Div., Washington, DC (USA). Sep 1989. 28p. Available from NTIS, PC A03/MF A01.

See also PB–90-217340.

Heat fusion is the most common joining method for polyethylene gas distribution piping. Butt fusion was studied with the intent of relating the quality of the joint to the joining conditions. A semi-empirical approach was used. The thermofluid consequences of joining conditions such as heater temperature, heating time and joining parameter were calculated using a computer model. The model was validated by instrumented tests. The strength of the joints was gauged by destructive mechanical testing. Tensile and tensile impact tests were used. Over 150 joints were fabricated using four different polyethylene resins. Most of the data are given in GRI Report No. 88/0276.2 – Volume 2: Technical Reference on Butt Heat Fusion Joining of Polyethylene Gas Pipes. A parameter, termed the Joining Parameter, was found to characterize the joining conditions. Of the mechanical tests parameters, the impact energy was found to have the best correlation with the joining parameter. The results for four resins are presented in the form of four nomographs given in the report – Volume 1.

40379 (PB–90-217340/XAB) **Technical reference on butt heat-fusion joining of polyethylene gas pipes. Topical report, July 1986-September 1989. Volume 2.** Pimputkar, S.M.; Cassady, M.; McCoy, J.K.; Stets, J.A.; Uralil, F. Battelle Columbus Div., Washington, DC (USA). Sep 1989. 309p. Available from NTIS, PC A14/MF A02.

See also PB–90-217332.

Heat fusion is the most common joining method for polyethylene gas distribution piping. Butt fusion was studied with the intent of relating the quality of the joint to the joining conditions. A semi-empirical approach was used. The thermofluid consequences of joining conditions such as heater temperature, heating time and joining parameter were calculated using a computer model. The model was validated by instrumented tests. The strength of the joints was gauged by destructive mechanical testing. Tensile and tensile impact tests were used. Over 150 joints were fabricated using four different polyethylene resins. Most of the data are given in GRI Report No. 88/0276.2 – Volume 2: Technical Reference on Butt Heat Fusion Joining of Polyethylene Gas Pipes. A parameter, termed the Joining Parameter, was found to characterize the joining conditions. Of the mechanical tests parameters, the impact energy was found to have the best correlation with the joining parameter. The results for four resins are presented in the form of four nomographs given in the report – Volume 1.

40380 (PB–90-219601/XAB) **Measurements of coefficients of discharge for concentric flange-tapped square-edged orifice meters in natural gas over the Reynolds Number range 25,000 to 16,000,000. Technical note (Final).** Whetstone, J.R.; Cleveland, W.G.; Bateman, B.R.; Sindt, C.F. National Inst. of Standards and Technology, Boulder, CO (USA). Center for Chemical Engineering. Sep 1989. 369p. (NIST/TN–1270). Available from NTIS, PC A16/MF A02.

Also available from Supt. of Docs. as SN003-003-02974-2.

The report describes the data acquisition systems and procedures used in the American Petroleum Institute (API)-sponsored orifice discharge coefficient project performed in natural gas flows and conducted at the test loop of the Natural Gas Pipeline Company of America (NGPL) in Joliet, Illinois. Measurements of orifice discharge coefficients for 6- and 10-inch diameter orifice meter runs were made using critical venturis for mass flowrate measurement with associated measurement of pressures and temperatures. Eleven venturis were calibrated at the Colorado Engineering Experiment Station, Inc. (CEESI). Measurements of absolute and differential pressure and temperature for venturi and orifice meter conditions were made using an automated data acquisition system. Temperature and pressure measurements were directly related to U.S. national measurement standards. Daily calibration of absolute and differential pressure transducers using pressure working standards was designed into the measurement procedures. Collected over a 2-year period, the database contains tests on 44 orifice plates in 8 beta ratios for two meter sizes (6- and 10-inches). The database contains 1,345 valid test points.

0330 Properties and Composition

40381 (PB–90-222456/XAB) **Method and apparatus for direct determination of helium-3 in natural gas and helium. Report of Investigations/1990.** Davidson, T.A.; Emerson, D.E. Bureau of Mines, Amarillo, TX (USA). Helium Field Operations. 1990. 21p. (BUMINES-RI–9302). Available from NTIS, PC A03/MF A01.

Library of Congress catalog card No. 89-600356.

The Bureau of Mines Helium Field Operations has developed a method for determining the helium-3 (^3He) content of natural gas and mixtures containing 0.5% to 100% helium. The helium is preconcentrated by passing samples through anhydrone, a liquid-nitrogen-cooled charcoal trap, and a titanium absorption trap. The mass spectrometer used to analyze the samples is turned to ^3He at m/e = 3.016. Hydrogen deuteride interference is minimized by the titanium absorption trap and high instrument resolution. Sample measurements are compared with identically made measurements of a gravimetrically prepared primary standard. The method has a limit of detection of 0.15 ppb with a relative deviation of 13% below the 1-ppb level. The relative deviation is less than 7% for gases containing over 100 ppb ^3He. The helium isotope ratios of natural gases from the Bureau's Tuck-Trigg Dome Red Cave, the Bush Dome Red Cave, and the Bush Dome Brown Dolomite Formations are distinguishable from one another and from the isotope ratio of crude helium produced from the Panhandle-Hugoton Gasfield.

40382 **Activation of methane by transition metal-substituted aluminophosphate molecular sieves.** Maroni, V.A. (Argonne National Lab., IL (USA)); Williams, K.A.; Nguyen, Hiephoa; Iton, L.E. *Preprints of Papers, American Chemical Society, Division of Fuel Chemistry (USA),* 35(2): 584-591 (1990). DOE Contract W-31-109-ENG-38. (CONF-900402–: 199. national meeting of the American Chemical Society, Boston, MA (USA), 22-27 Apr 1990).

Recent experiments in the authors laboratory have demonstrated that aluminophosphate molecular sieves substituted with cobalt and cobalt/silicon combinations and having the $AlPO_4$-34 or $AlPO_4$-5 structure activate methane starting at ~350°C. Between 400 and 500°C the rate of methane conversion increases steadily with typical conversion efficiencies at 500°C ranging from 15 to 60%. The cobalt and silicon substituted $AlPO_4$-34 structure (CoAPSO-34) produces ethylene, ethane, propylene, and propane in varying proportions, depending on reaction conditions. The cobalt-substituted $AlPO_4$-5 (CoAPSO-5) produces propylene in very high yield, with ethane, ethylene, and propane also seen.

0340 Combustion

40383 (PB–90-216698/XAB) **Advanced Natural Gas Fired Cyclonic Burner/Boiler Development. Annual report, April 1988-April 1989.** Chojnacki, D.A. Donlee Technologies, Inc., York, PA (USA). York-Shipley Div. Jan 1990. 65p. Available from NTIS, PC A04/MF A01.

The report describes the first phase development of an Advanced Natural Gas Fired Cyclonic Burner/Boiler, (CB/B), for the 250 hp to 2500 hp industrial boiler market. Cyclonic combustion of natural gas is accomplished by injecting natural gas and combustion air tangentially, at high velocity, into a cylindrical combustion chamber. The high tangential velocity of cyclonic combustion results in the swirling combustion flow pattern that enhances the heat transfer to the boiler. The cyclonic combustion also creates high internal recirculation which serves to reduce flame temperature, improve air/fuel mixing and reduce combustion emissions. The CB/B concept, consisting of a low NOx high intensity two-stage cyclonic burner, a watertube wall furnace and a firetube type steam drum, is shown to be technically feasible and economically viable. A 2.5 MMBtu/hr pilot scale two-stage cyclonic burner was successfully tested and achieved NOx of less than 25 ppm with 5% excess air. A 250 hp (10 MMBtu/hr) CB/B Industrial Prototype unit has been designed to achieve 85% efficiency.

40384 (PB–90-216730/XAB) **Reducing pollutant emissions: Gas finds a new niche.** Gas Research Inst., Chicago, IL (USA). Jun 1986. 9p. (GRI–86/0326). Available from NTIS, PC A02/MF A01.

Color illustrations reproduced in black and white.

GRI is researching new technologies for using natural gas to control emissions from utility and industrial boilers. GRI's program emphasizes integrating gas reburning with gas-enhanced dry sorbent injection for simultaneous reduction of NOx and SOx emissions. Research projects are described, and the potential market and competing environmental control techniques are discussed.

04 OIL SHALES AND TAR SANDS

0403 Drilling, Fracturing, and Mining

40385 (PB–90-868696/XAB) **Tar sands. June 1970-November 1983 (A Bibliography from the COMPENDEX data base). Report for June 1970-November 1983.** National Technical Information Service, Springfield, VA (USA). May 1990. 117p. Available from NTISPC N01/MF N01.

See also PB–90-868704.

This bibliography contains citations concerning mining processes and recovery of tar sands from bitumen and other materials. The physical and chemical properties of tar sands are discussed, and the economics of their recovery are considered. (This updated bibliography contains 164 citations, none of which are new entries to the previous edition.)

40386 (PB–90-868704/XAB) **Tar sands. December 1983-March 1990 (A Bibliography from the COMPENDEX data base). Report for December 1983-March 1990.** National Technical Information Service, Springfield, VA (USA). May 1990. 164p. Available from NTISPC N01/MF N01.

Supersedes PB–84-854017. See also PB–90-868696.

This bibliography contains citations concerning mining processes and recovery of tar sands from bitumen and other materials. The physical and chemical properties of tar sands are discussed, and the economics of their recovery are considered. (This updated bibliography contains 352 citations, all of which are new entries to the previous edition.)

0404 Oil Production, Recovery, and Refining

Refer also to citation(s) 40385, 40386

0405 Properties and Composition

Refer also to citation(s) 40385, 40386

0408 Economic, Industrial, and Business Aspects

Refer also to citation(s) 40385, 40386

05 NUCLEAR FUELS

Refer also to citation(s) 40687

0504 Feed Processing

40387 (AECS-FRSR–25) **Search for a developed method for the determination of Fe_2 and Fe_3 in Syrian Phosphoric acid.** Elian, Nuzhat (Atomic Energy Commission, Damascus (Syria)); Kalak, Issam. Atomic Energy Commission, Damascus (Syria). Aug 1988. 14p. (In Arabic). Order Number DE90633239. Available from Also published in Aalam Al-Zarra (May 1989) no. 8 p. 81-86.

Phosphoric acid is the most important precursor for uranium production in Syria. Uranium extraction from phosphoric acid depends on the chemical composition of the acid, and most important is the relation between the proportions of $iron_{II}$/$iron_{III}$, and $uranium_{IV}$/$uranium_{VI}$, this proportion plays a very important role in different steps of the extraction. For this purposes two methods for determination of $Iron_{II}$ and $Iron_{III}$ in Syrian wet phosphoric acid spectrophotometrically were studied. The first one used 1.10 phenanthroline as complex agent. $Iron_{II}$ formed red complex with 1.10 phenonstholine in the range of pH between 4 and 6, for

determination of total iron. Iron$_I$II was reduced to Iron$_I$I with hydroxylamine hydrochloride. The second method used sulfosalycilic acid, Iron$_I$II formed a yellow complex with sulfosalycilic acid. Total iron was determined in ammonium medium, but Iron$_I$II was determined in pH=1.5. The sensibility of the two methods and stability of their complex have been studied in normal laboratory conditions. 45 refs., 4 figs. (author).

40388 (PB–90-869777/XAB) **Uranium ore treatment. January 1970-May 1981 (A Bibliography from the COMPENDEX data base). Report for January 1970-May 1981.** National Technical Information Service, Springfield, VA (USA). May 1990. 267p. Available from NTISPC N01/MF N01.

See also PB–90-869785.

The treatment of uranium ores is reviewed with emphasis placed on acid leaching as the primary step in the process. Tailing disposal and proper handling of radioactive materials is emphasized. Primary treatment procedures include ion-exchange, sulfuric acid leaching, solvent extraction, and sedimentation. Environmental aspects of uranium milling and mining are examined in a related published bibliography. (This updated bibliography contains 300 citations, none of which are new entries to the previous edition.)

40389 (PB–90-869785/XAB) **Uranium ore treatment. June 1981-March 1990 (A Bibliography from the COMPENDEX data base). Report for June 1981-March 1990.** National Technical Information Service, Springfield, VA (USA). May 1990. 110p. Available from NTISPC N01/MF N01.

Supersedes PB–81-864290. See also PB–90-869777.

The treatment of uranium ores is reviewed with emphasis placed on acid leaching as the primary step in the process. Tailing disposal and proper handling of radioactive materials is emphasized. Primary treatment procedures include ion-exchange, sulfuric acid leaching, solvent extraction, and sedimentation. Environmental aspects of uranium milling and mining are examined in a related published bibliography. (This updated bibliography contains 265 citations, all of which are new entries to the previous edition.)

0505 Uranium Enrichment

40390 (IAE–4635-12) **Separation work: an energy approach to the definition of the concept in the theory of gaseous mixture enrichment.** Potanin, E.P. Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow (USSR). Inst. Atomnoj Ehnergii. 1988. 8p. (In Russian). Order Number DE90633953. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

An attempt to discover physical meaning of the concepts separation work, separation power or separation capacity, as well as the units of separation work, which are usually used in economical calculations of uranium isotope separation. It is shown that introduction into the theory of gaseous mixture enrichment of the so-called separation potential of Dirac-Peierls (Φ) is related to fulfillmant of the law of conservation of mechanical work when separating components. Possibility of obtaining the expression for Φ potential from consideration of changes in the potential energy of mixture molecules in the process of mutual diffusion is shown, taking separation of a binary gaseous mixture in the external force field as an examples.

0507 Fuels Production and Properties

Refer also to citation(s) 40688, 41293

40391 (ANL–89/44-Rev.1) **PC-DYMAC: Personal Computer-DYnamic Materials ACcounting: Revision 1.** Jackson, B.G. Argonne National Lab., Idaho Falls, ID (USA). Jun 1990. 154p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract W-31109-ENG-38. Order Number DE90013541. Available from NTIS, PC A08/MF A01 - OSTI; GPO Dep.

This manual was designed to provide complete documentation for the computer system used by the EBR-II Fuels and Materials Department, Argonne National Laboratory-West (ANL-W) for accountability of special nuclear materials (SNM). This document includes background information on the operation of the Fuel Manufacturing Facility (FMF), instructions on computer operations in correlation with production and a detailed manual for PC-DYMAC operation. 2 refs., 60 figs.

40392 (LA–11896-MS) **A literature review on the chemical and physical properties of uranyl fluoride (UO_2F_2).** Myers, W.L. (Los Alamos National Lab., NM (USA)). Los Alamos National Lab., NM (USA). Aug 1990. 18p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-36. Order Number DE90014409. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This report reviews the preparation and properties of uranyl fluoride. Data are given on the crystal structure, solubility in water, specific gravity, density, specific heat, enthalpy, entropy, acidity, corrosion properties, and refractive indices. Empirical formulas are given to calculate specific gravity, density of aqueous solutions, molal volume, and refractive indices. 13 refs., 3 figs., 11 tabs.

40393 (SAND–90-0767C) **Performance of prototype authentication equipment for A C/S system at the Plutonium Fuel Production Facility.** Johnson, C.S. (Sandia National Labs., Albuquerque, NM (USA)); Hale, W.R.; Martinez, R.L.; Ohtani, T.; Takahashi, S.; Seya, M. Sandia National Labs., Albuquerque, NM (USA). [1990]. 5p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. (CONF-9007106–14: Institute of nuclear materials management conference, Los Angeles, CA (USA), 15-18 Jul 1990). Order Number DE90013839. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

The Power Reactor and Nuclear Fuel Development Corporation (PNC) designed an Advanced Containment and Surveillance System (A C/S) for its Plutonium Fuel Production facility at Tokai-Mura, Japan. PNC entered into an agreement with the US Department of Energy (DOE) to have Sandia National Laboratories (SNL) develop options for authenticating the information provided by the A C/S System, as well as to develop PNC-selected hardware for demonstration purposes. The equipment was installed in the early summer of 1989, and has undergone performance evaluation since that time. The key technologies being evaluated include authentication item monitoring, video and digital signal authentication, and event data logging, plus the system integration of these components. A review of the performance of this equipment will be highlighted. 3 refs., 4 figs.

0508 Spent Fuels Reprocessing

Refer also to citation(s) 40461, 41114, 41115, 41120, 41124

40394 (BMU–1990-253) **Waste recycling from reprocessing.** Schriftenreihe Reaktorsicherheit und Strahlenschutz. Ergebnisberichte, Untersuchungen, Studien, Gutachten. Friehmelt, V.; Gidarakos, E.; Koehling, A.; Langer, G.; Schmitt, R.E.; Ulrici, W. Bundesministerium fuer Umwelt-, Naturschutz und Reaktorsicherheit, Bonn (Germany, F.R.); Battelle-Institut e.V., Frankfurt am Main (Germany, F.R.). Oct 1989. 167p. (In German). Contract BMU SR 412. (BF-R–66.884-01). Available from GRM Werbeberatung - Werbemittlung - PR, Eggenstein-Leopoldshafen, (Germany, F.R.).

On the base of published information economic and safety conditions are given which allow reclaiming of valuable materials from the waste streams of the PUREX-process. The cladding, structural material and end fittings from fuel elements and scrap material arising from repair and servicing of the reprocessing pland, the offgas from the head end, the dissolver sludge and HLW have been evaluated. (DG).

40395 (LA–11827-MS) **Determination of plutonium concentration and isotopic compositions by isotope dilution gamma-ray spectroscopy on resin beads.** Li, T.K. (Los Alamos National Lab., NM (USA)); Parker, J.L.; Kuno, Y.; Nakatsuka, K.; Kaminaga, K.; Akiyama, T. Los Alamos National Lab., NM (USA). May 1990. 13p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-36. (PNC-TN–8410-90-001). Order Number DE90013531. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

We have developed a new technique for simultaneously determining the plutonium concentration and the isotopic composition of

highly irradiated fuel dissolver solutions, such as the input to a chemical reprocessing plant. This technique combines the high-resolution, low- energy, gamma-ray spectroscopy technique, the isotope dilution technique, and the resin head technique in one; it is referred to as isotope dilution gamma-ray spectroscopy (IDGS). The IDGS involves adding a well-characterized plutonium isotope to the unknown solution and then extracting the plutonium from the spiked (mixed) solution on resin beads and subsequently measuring the beads with high-resolution gamma-ray spectroscopy. The spike used in this experiment is a large size spike of ^{239}Pu. The plutonium concentration of the dissolver solution obtained from the first IDGS measurement agrees with that obtained by isotope dilution mass spectrometry within 0. 042%. 4 refs., 4 figs., 4 tabs.

40396 (WHC-SA–0641) **PUREX [Plutonium-Uranium Extraction] L-Cell concentrator corrosion evaluation.** Compton, J.A.; Delegard, C.H. Westinghouse Hanford Co., Richland, WA (USA). May 1990. 44p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC06-87RL10930. (CONF-8910260–6: Plutonium/uranium recovery operations conference, Oak Ridge, TN (USA), 24-26 Oct 1989). Order Number DE90013275. Available from NTIS, PC A04/MF A01 - OSTI; GPO Dep.

Problems with solids plugging the piping associated with the E-L7-1 concentrator at the Plutonium-Uranium Extraction (PUREX) Plant were experienced shortly after it was put into use in 1971. The transfer line from the concentrator was first plugged in 1972. The PUREX Plant was shut down shortly thereafter after processing of available feed was finished. The plant was restarted in 1983, and plugging occurred again in early 1985. Both times, the transfer line was cleared by pulsing the fluid. The transfer line was replaced because of plugging in mid-1986 when pulsing failed to remove the plug. The concentrator, which is made of titanium, is used for the final concentration of the plutonium nitrate solution. The solids plugging the transfer line were identified as both the rutile and anatase forms of titanium dioxide. Ultrasonic examinations of titanium equipment in L-Cell showed that the concentrator wall thickness was decreasing as the acid refluxing area of the E-L7-1 tower was approached. The PUREX Plant Systems and Technology then requested the Plutonium Process Support Laboratories (PPSL) to set up and perform experiments to determine the cause(s) and possible corrective actions for the E-L7-1 corrosion. After testing samples of titanium and other metals under controlled conditions identical to E-L7-1 concentrator operation, zirconium was selected for long-term testing as a replacement for the tower section. Two long-term test apparatus were then built and tested on a pilot scale. 9 refs., 13 figs., 5 tabs.

0509 Transport, Handling, and Storage

Refer also to citation(s) 40469

0520 Waste Management

Refer also to citation(s) 40388, 40389, 40460, 40772, 42060

40397 (AD-A–220132/5/XAB) **Air Force Nuclear Engineering Center structural activation and integrity evaluation. Master's thesis.** Lamb, W.A. Air Force Inst. of Tech., Wright-Patterson AFB, OH (USA). School of Engineering. Mar 1990. 114p. (AFIT/GNE/ENP–90M-4). Available from NTIS, PC A06/MF A01.

The purpose of this study was to investigate three areas; the entombed radioactivity of the Air Force Nuclear Engineering Center (AFNEC) Test Facility located in Area B, Building 470, Wright-Patterson AFB, Ohio, the integrity of the materials encased in the concrete to determine if they would be susceptible to corrosion or deterioration, and the comparison of cost of dismantlement of the existing facility or continued surveillance of the existing facility. The ORIGEN2 computer code was used to calculate an upper bound of radioactivity entombed within AFNEC. The initial calculated activity, 2,460,000 Curies, has decayed by three orders of magnitude since the cessation of operation (20 years later - 1,560 Curies). The activated structural components consisted of 5 distinct materials; aluminum, stainless steel, carbon steel, lead, and concrete. Of these materials, aluminum dominated the initial radioactivity with nearly 60% of the total activity attributed to it. The carbon steel became the dominant contributor to the total radioactivity with over 50% of the total activity at 20 years after shutdown.

40398 (BMU–1989-223) **Parameter variation of the transport of selected radionuclides in the geosphere.** Schriftenreihe Reaktorsicherheit und Strahlenschutz. Ergebnisberichte, Untersuchungen, Studien, Gutachten. Maravic, H. v.; Baltes, B. Bundesministerium fuer Umwelt-, Naturschutz und Reaktorsicherheit, Bonn (Germany, F.R.); Gesellschaft fuer Reaktorsicherheit mbH (GRS), Koeln (Germany, F.R.). Mar 1989. 43p. (In German). Contract BMU SR 389. (GRS-A–1537). Available from GRM Werbeberatung - Werbemittlung - PR, Eggenstein-Leopoldshafen, (Germany, F.R.).

Using the KONRAD repository as an example, the impact of individual input parameters of the analytical solution of the transport equation on the maximum concentration in quaternary aquifers and on the nuclide transit times was examined by means of variation of parameters and the results for the nuclides Se, Np, J and U were shown in diagrams for a migration path in a model area. As parameters the distribution coefficient (K_D-value), the longitudinal dispersion length and waterflow velocity were varied. For the nuclides Se and J in addition the influence of various leaching times on the nuclide concentration and thereby on the nuclide transit time were examined. As a result of the parameter variation it is clear, that the influence of dispersion length and the distribution coefficient on the nuclide transit time and the nuclide concentration is decisively dependent on the magnitude of water velocity in aquifers and on the nuclide-specific half-time. (orig./DG).

40399 (CONF-900977–1) **A proposed strategy for upgrade of the ORNL Process Wastewater Treatment Plant.** Kent, T.E.; Robinson, S.M.; Scott, C.B. Oak Ridge National Lab., TN (USA). [1990]. 7p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. From Spectrum '90: working toward a cleaner environment; Knoxville, TN (USA); 30 Sep - 4 oct 1990. Order Number DE90011387. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

An approach to the upgrade of the radiological Process Wastewater Treatment Plant (PWTP) at Oak Ridge National Laboratory (ORNL) has been developed that, if adopted, will result in significant cost reductions and improved water quality. The strategy described in this report satisfies the short-term upgrade needs of the PWTP and ultimately results in replacement of existing PWTP softening/ion- exchange technology with a zeolite molecular sieve treatment system for removal of radioactive contaminants from process wastewater. Use of zeolites will improve wastewater quality while reducing operating and disposal costs. The zeolite system would be constructed adjacent to the site now occupied by the Non-Radiological Process Wastewater Treatment Plant (NRWTP), thereby consolidating all process wastewater treatment systems at one location. 4 refs., 4 figs.

40400 (CONF-9006233–1) **Radioactive waste definitions, standards, criteria, and approaches in the United States of America.** Nelson, R. (USDOE, Washington, DC (USA)); Forsberg, C.W. Oak Ridge National Lab., TN (USA). Jun 1990. 24p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC05-84OR21400. From USA-USSR radioactive waste management exchange meeting; Moscow (USSR); 20 Jun 1990. Order Number DE90013280. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This paper provides an overview of the structure of the radioactive waste management system in the United States. Included are definitions, standards, organizational structure, and general technical approaches to radioactive waste management. It must be noted that the US waste management systems have evolved with time toward more consistent, uniform approaches. There are specific exceptions to general practice, but they are not discussed here. 18 refs., 4 tabs.

40401 (CONF-9007106–35) **Application of nondestructive assay technology in Oak Ridge National Laboratory's waste management program.** Schultz, F.J.; Smith, M.A.; Brandenburg, R.W.; Caylor, B.A.; Coffey, D.E.; Hensley, D.C.; Phoenix, L.B. Oak Ridge National Lab., TN (USA). [1990]. 9p. Sponsored by U.S.

DOE Energy Research. DOE Contract AC05-84OR21400. From Institute of nuclear materials management conference; Los Angeles, CA (USA); 15-18 Jul 1990. Order Number DE90014451. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

Waste characterization is the process whereby physical properties and chemical composition of waste are determined. Waste characterization is an important element of a waste certification program in that it provides information which is necessary to certify that waste meets the acceptance criteria for storage, treatment, or disposal. Department of Energy (DOE) Order 5820.2A and WIPP-DOE-069 list and describe the germane waste form, package, and container criteria for the storage of both solid low-level waste (SLLW) and transuranic (TRU) waste, including chemical composition and compatibility, hazardous material content, fissile material content, equivalent alpha activity, thermal heat output, and absence of free liquids, explosives, and compressed gases. At the Oak Ridge National Laboratory (ORNL), the responsibility for waste characterization begins with the individual(s) who generate the waste. The generator must be able to document the type and estimate the quantity of various materials which have been placed into the waste container. Analyses of process flow sheets and a statistically valid sampling program can provide much of the required information as well as a documented level of confidence in the acquired data. A program is being instituted in which the major generator facilities perform radionuclide assay of small packets of waste prior to being placed into a waste drum. 10 refs., 1 fig., 1 tab.

40402 (CONF-9009110–1) **Integrated Data Base: Status and waste projections.** Klein, J.A. Oak Ridge National Lab., TN (USA). [1990]. 15p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC05-84OR21400. From Joint ANS/ASME nuclear engineering conference; Newport, RI (USA); 16-20 Sep 1990. Order Number DE90009243. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

The Integrated Data Base (IDB) is the official US Department of Energy (DOE) data base for spent fuel and radioactive waste inventories and projections. DOE low-level waste (LLW) is just one of the many waste types that are documented with the IDB. Summary-level tables and figures are presented illustrating historical and projected volume changes of DOE LLW. This information is readily available through the annual IDB publication. Other presentation formats are also available to the DOE community through a request to the IDB Program. 4 refs., 6 figs., 5 tabs.

40403 (CONF-9009110–2) **Progress on developing expert systems in waste management and disposal.** Rivera, A.L.; Ferrada, J.J. Oak Ridge National Lab., TN (USA). [1990]. 6p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC05-84OR21400. From Joint ANS/ASME nuclear engineering conference; Newport, RI (USA); 16-20 Sep 1990. Order Number DE90012174. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The concept of artificial intelligence (AI) represents a challenging opportunity in expanding the potential benefits from computer technology in waste management and disposal. The potential of this concept lies in facilitating the development of intelligent computer system to help analysts, decision makers, and operators in waste and technology problem solving similar to the way that machines support the laborer. Because the knowledge of multiple human experts is an essential input in the many aspects of waste management and disposal, there are numerous opportunities for the development of expert system using software products from AI. The spectrum of opportunities for expert systems development ranges from identification of waste and technology research needs to real-time control of waste management and disposal operations. This paper presents systems analysis as an attractive framework for the development of intelligent computer systems of significance to waste management and disposal, and it provides an overview of limited prototype systems and the commercially available software used during prototype development activities. 11 refs., 6 figs.

40404 (CONF-9009178–1) **Improved techniques for monitoring well screen placement and well location.** Baker, L.A. (Automated Sciences Group, Inc., Oliver Springs, TN (USA)); Reynolds, M.D.; Nickelson, M.D. Martin Marietta Energy Systems, Inc., Oak Ridge, TN (USA). [1990]. 4p. Sponsored by U.S. DOE Environment Health & Safety. DOE Contract AC05-84OT21400. From Spectrum 90 international topical meeting; Knoxville, TN (USA); 30 Sep - 4 oct 1990. Order Number DE90012736. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

One of the prime objectives for using monitoring wells in hazardous waste investigations is to collect water quality data representative of actual aquifer conditions. It is important that the horizontal and vertical placement of well screens be chosen to yield the most beneficial analytical data. The problem of optimal well placement is confounded by the lack of analytical data available during well installation. To compensate for the lack of information, many hydrogeologists either randomly place wells or align wells in an upgradient-downgradient alignment with respect to a specific source area. There are several drawbacks to this approach. This paper presents field methods that allow the investigation to vertically place the screened interval and horizontally locate the monitoring well during one mobilization so that maximum benefit can be obtained. Specifically, a case study is presented in which a plunging plume 2500 ft wide, 8000 ft long, and 35 ft thick in an unconfined aquifer was accurately defined in one field mobilization. 1 tab.

40405 (DOE/RL–89-03-Rev.1) **616 Nonradioactive Dangerous Waste Storage Facility Dangerous Waste Permit Application.** USDOE Richland Operations Office, WA (USA). Jun 1990. 663p. Sponsored by U.S. DOE Nuclear Energy. Order Number DE90014394. Available from NTIS, PC A99/MF A01 - OSTI.

The Hanford Site is operated by the US Department of Energy-Richland Operations Office. The 616 Nonradioactive Dangerous Waste Storage Facility receives and stores nonradioactive dangerous waste from various Hanford Site generating units until the waste can be transported offsite for treatment, storage, and/or disposal. Westinghouse Hanford Company is a major contractor to the US Department of Energy-Richland Operations Office and serves as co- operator of the 616 Nonradioactive Dangerous Waste Storage Facility, the waste management unit addressed by this permit application. The 616 Nonradioactive Dangerous Waste Storage Facility Dangerous Waste Permit Application consists of both a Part A and a Part B permit application. An explanation of the Part A revisions associated with this waste management unit, including the one submitted with this document, is provided at the beginning of the Part A Section. The Part B consists of 15 chapters addressing the organization and content of the Part B Checklist prepared by the Washington State Department of Ecology (Ecology 1987). For ease of reference, the checklist section numbers, in brackets, follow chapter headings and subheadings.

40406 (DOE/RW–0269P-1) **Quarterly report on program cost and schedule, second quarter FY 1990.** USDOE Office of Civilian Radioactive Waste Management, Washington, DC (USA). [1990]. 29p. Sponsored by U.S. DOE Radioactive Waste Management. Available from OSTI (Free of Charge).

This report is intended to provide a summary of the cost and schedule performance for the Civilian Radioactive Waste Management Program. Historical and current cost profiles are presented for each of the major program elements. Also included in this report is the status of the Nuclear Waste Fund revenues and disbursements. This report includes data through March 1990. 1 fig.

40407 (DOE/RW–0272P) **Waste Management System Requirement document: Volume 3, MRS [Monitored Retrievable Storage].** USDOE Office of Civilian Radioactive Waste Management, Washington, DC (USA). Apr 1990. 40p. Sponsored by U.S. DOE Radioactive Waste Management. Available from OSTI (Free of Charge); INIS.

This volume defines the top level technical requirements for the Monitored Retrievable Storage (MRS) facility. It is designed to be used in conjunction with Volume 1, General System Requirements. Volume 3 provides a functional description expanding the requirements allocated to the MRS facility in Volume 1 and, when appropriate, elaborates on requirements by providing associated performance criteria. Volumes 1 and 3 together convey a minimum set of requirements that must be satisfied by the final MRS facility design without unduly constraining individual design efforts. The requirements are derived from the Nuclear Waste Policy Act of 1982

(NWPA), the Nuclear Waste Policy Amendments Act of 1987 (NWPAA), the Environmental Protection Agency's (EPA) Environmental Standards for the Management and Disposal of Spent Nuclear Fuel (40 CFR 191), NRC Licensing Requirements for the Independent Storage of Spent Nuclear and High-Level Radioactive Waste (10 CFR 72), and other federal statutory and regulatory requirements, and major program policy decisions. This document sets forth specific requirements that will be fulfilled. Each subsequent level of the technical document hierarchy will be significantly more detailed and provide further guidance and definition as to how each of these requirements will be implemented in the design. Requirements appearing in Volume 3 are traceable into the MRS Design Requirements Document. Section 2 of this volume provides a functional breakdown for the MRS facility. 1 tab.

40408 (GSF–5/89) **Geochemical processes observed during the flooding of the Hope potash salt mine. Final report of partial project 'geochemistry' of R and D project Hope. Examinations of processes relevant to final storage prior, during and after the flooding of the Hope potash salt mine.** Herbert, H.J. Gesellschaft fuer Strahlen- und Umweltforschung mbH Muenchen, Braunschweig (Germany, F.R.). Inst. fuer Tieflagerung; Kavernen Bau- und Betriebsgesellschaft mbH, Hannover (Germany, F.R.). 1989. 165p. (In German). Contract BMFT KWA 5311;BMFT KWA 8307/7;GSF 77272. (GSF-TL–3/89). Order Number DE90510114. Available from NTIS (US Sales Only), PC A08/MF A01.

This report is the final report of the partial project GEOCHEMISTRY of the R+D Task 'Examinations of processes relevant to final storage prior, during and after flooding of the Hope potash salt mine. The research project has been terminated, except for a portion of a geo-chemical measurement program, after 5 years duration in May 1988. Among the 16 measurement points installed on 4 different brine wells of the Hope mine, 5 were designated for geo-chemical examinations. They served for the determination of dissolving and precipitation activities of salts, the transport processes, the temperature distribution and the inherent development and efficiency of geo-chemical barriers in the caustic solution. The successful continuous test of the individual measuring systems led to a ready to use, patented new development for measurement and sampling of salt-solutions and gases in exploratory drillings even under crititcal conditions, i.e. high pressure. (orig./RB).

40409 (GSF–26/86) **Groundwater movement in the overlying rock and at the flumes of the salt wash surface in the Asse salt stock.** Schoenfeld, E. Gesellschaft fuer Strahlen- und Umweltforschung mbH Muenchen, Neuherberg (Germany, F.R.). Inst. fuer Radiohydrometrie; Muenchen Univ. (Germany, F.R.). Fakultaet fuer Geowissenschaften. Jul 1986. 111p. (In German). Order Number DE90510111. Available from NTIS (US Sales Only), PC A06/MF A01.

There are two groundwater storeys in the Asse massif. One within the overlaying rock and one at the flumes of the top of the salt plug. Both groundwater storeys are hydraulically connected via two points of contact. With the exception of this connecting path between overlaying rock and top of salt plug no further connecting path of this kind is known in the investigation area. Due to the petrographic formation of the strata in the investigation area, the decisive groundwater flow is only possible in the joints. (orig./PW).

40410 (JAERI-M–90-023) **Development of partitioning method: Continuous extraction of neptunium with DIDPA and continuous stripping with oxalic acid.** Tani, Shyunji (Japan Atomic Energy Research Inst., Tokai, Ibaraki (Japan). Tokai Research Establishment); Morita, Yasuji; Kubota, Masumitsu. Japan Atomic Energy Research Inst., Tokyo (Japan). Feb 1990. 37p. (In Japanese). Order Number DE90508082. Available from NTIS (US Sales Only), PC A03/MF A01.

Solvent extraction process with DIDPA (diisodecyl phosphoric acid) and stripping process with oxalic acid have been studied for the purpose of separating Np(V) from high-level liquid waste. The present paper describes studies on continuous counter-current extraction and stripping using a miniature mixer-settler to examine the industrial applicability of these two processes. It was found that more than 99.96% of Np(V) could be extracted with DIDPA from simulated high-level liquid waste with addition of hydrogen peroxide. Hydrogen peroxide decomposed in the mixer-settler under the influence of some elements such as Pd, and then the acceleration of Np extraction by hydrogen peroxide was reduced. However, it was found possible to increase the Np extraction rate again by resupply of hydrogen peroxide. In the experiment on stripping, it was found that more than 99.94% of Np(IV) could be stripped with 0.8M oxalic acid from DIDPA. The stripping behavior of Np was well explained by the distribution ratios obtained through batchwise experiments. (author).

40411 (Juel-Spez–498) **Computed tomography of radioactive waste drums.** Duwe, R.; Jansen, P. Kernforschungsanlage Juelich GmbH (Germany, F.R.). Inst. fuer Reaktorwerkstoffe; Forschungszentrum Juelich GmbH (KFA) (Germany, F.R.). Zentralinstitut fuer Angewandte Mathematik. 18 Apr 1989. 49p. (In German). Order Number DE90510116. Available from NTIS (US Sales Only), PC A03/MF A01.

Before waste drums with radioactive waste are stored in a repository, especially the inventory of radionuclides must be indicated to the operator of the final storage facility. If cemented waste with a relatively high density is concerned, a considerable part of the γ radiation is absorbed in the drum itself, so that a non-destructive check up of the declaration is rendered difficult as soon as the activities in the drum are inhomogeneously distributed or for example an internal container exists in the drum. A tomography measuring method (SPECT, TCT with Sb-124) was developed and a measuring unit was installed in the hot cells. There the necessary measurements for the calculation of the density distribution and also of the activity distribution in any drum section can be carried out. With the help of an iterative reconstruction programme the distribution of the density or activity in the section is determined from the measuring curves, as test measurements with real waste drums and test objects show. A further development of the device will permit in future its application beyond laboratory scale for randomly checking contaminated waste. (orig./HP).

40412 (KFK–4643) **The real structure of hollandite, zirconolite, and alumosilicates in SYNROC A.** Maier, V. Kernforschungszentrum Karlsruhe GmbH (Germany, F.R.). Inst. fuer Nukleare Entsorgungstechnik; Kernforschungszentrum Karlsruhe GmbH (Germany, F.R.). Projekt Wiederaufarbeitung und Abfallbehandlung; Technische Hochschule Darmstadt (Germany, F.R.). Mar 1990. 128p. (In German). (PWA–56/89). Order Number DE90510166. Available from NTIS (US Sales Only), PC A07/MF A01.

In this study two samples of SYNROC A, one of them containing 15 wt. % of simulated waste, were investigated by light microscopy, scanning (SEM) and transmission (TEM) electron microscopy to characterize their texture and the real structure of the phases present. The main phases observed are zirconolite, hollandite ($K_2,Ba_xAl_{2x}Ti_{8-2x}O_{16}$), (hexa)celsian ($BaAl_2Si_2O_8$), and kaliophilite ($KalSiO_4$). This SYNROC is not yet optimized for the incorporation of nuclear waste. Main problems arise from pores which increase the internal surface and the large amount of a thermodynamically unstable glass phase containing main elements (Mo and REE) out of the waste. (orig./MM).

40413 (K/WM–5) **Report of foreign travel to Paris, France, June 1, 1990–June 12, 1990.** Van Hoesen, S.D.; Jones, L.S. Oak Ridge Gaseous Diffusion Plant, TN (USA). Jul 1990. 17p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC05-84OT21400. Order Number DE90014320. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The Martin Marietta Energy Systems, Inc., Team, consisting of representatives of the Engineering Division and Central Waste Management Division, participated in a technology exchange program on French — US low-level radioactive waste (LLW) management facility design, construction, and operation. Visits were made to the new French LLW disposal facility currently under construction, the Centre de Stockage de l'Aube (CSA), to the La Hague reprocessing facility to visit LLW conditioning and storage facilities, and to the operating LLW disposal facility, the Centre de Stockage de la Manche (CSM). A meeting was also held with representatives of the Agence National pour la Gestion des Dechets Radioactifs (ANDRA) to discuss overall French and Oak Ridge LLW disposal facility development programs and to review the status of the efforts being conducted under the current subcontract

with NUMATEC/Societe General pour les Techniques Nouvelles (SGN)/ANDRA.

40414 (KY/H–104-Rev.1) **Environmental restoration and waste management site specific plan for Oak Ridge Operation Office Paducah Gaseous Diffusion Plant: Revision 1.** Paducah Gaseous Diffusion Plant, KY (USA). 18 Jul 1990. 65p. Sponsored by U.S. DOE Environment Health & Safety. DOE Contract AC05-84OU21400. Order Number DE90014392. Available from NTIS, PC A04/MF A01 - OSTI; GPO Dep.

The Paducah Gaseous Diffusion Plant (PGDP) occupies 748 security-fenced acres located on a 3,400-acre tract in McCracken County, Kentucky, which was previously part of the Kentucky Ordnance Works. The principle objective on-site process at PGDP is the separation of uranium isotopes through gaseous diffusion. The process produces enriched uranium, which is used for nuclear fuel in commercial power plants and for military purposes. This document provides an overview of the major environmental and waste management concerns at PGDP, requirements for implementation, organization/management, corrective activities, environmental restoration, waste management options, compliance with National Environmental Policy Act (NEPA), reporting and data management, quality assurance and federal, state and local interactions. 12 refs., 6 figs., 5 tabs.

40415 (LBL–28428) **Diffusive release of radionuclides into saturated and unsaturated tuff.** Sadeghi, M.M.; Lee, W.W.L.; Pigford, T.H.; Chambre, P.L. Lawrence Berkeley Lab., CA (USA). Jan 1990. 5p. Sponsored by U.S. DOE Radioactive Waste Management. DOE Contract AC03-76SF00098. (CONF-900608–47: American Nuclear Society annual meeting, Nashville, TN (USA), 10-14 Jun 1990). Order Number DE90014307. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

In the proposed Yucca Mountain repository, packages of high-level waste are separated from surrounding unsaturated rock by a 2-cm air-gap annulus. If a waste package contacts the surrounding rock, if the annulus becomes filled with rock and rubble, or if the rock becomes saturated, there can exist pathways for release of dissolved radionuclides by liquid diffusion. We have applied the analytical solutions for time-dependent mass transfer of dissolved species through porous rock to predict the time-dependent release rates of key radionuclides. The expected ground-water velocities are so low that mass-transfer is predicted to occur predominantly by molecular diffusion in pore liquid. Conservatively, we neglect mass-transfer resistance from fuel cladding and failed metal containers. 6 refs., 3 figs.

40416 (LBL–28429) **The effective diffusion coefficient for porous rubble.** Sadeghi, M.M.; Lee, W.W.-L.; Pigford, T.H.; Chambre, P.L. Lawrence Berkeley Lab., CA (USA). Jan 1990. 5p. Sponsored by U.S. DOE Radioactive Waste Management. DOE Contract AC03-76SF00098. (CONF-900608–45: American Nuclear Society annual meeting, Nashville, TN (USA), 10-14 Jun 1990). Order Number DE90014037. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

Each waste package in the proposed Yucca Mountain repository is to be separated from surrounded unsaturated rock by a 2-cm air gap annulus. However, if the annulus becomes filled with rock and rubble, there can exist pathways for diffusive release of radionuclides through pore liquid, even if the repository remains unsaturated. The effective diffusion coefficient for radionuclide release through pore liquid in a rubble bed depends on the porosity and moisture content of rubble material and on the geometry and contact area of individual pieces of rubble. Here we present a theoretical analysis of the effective diffusion coefficient for a bed of rubble spheres. The results give a rough indication of the magnitude of the effective diffusion coefficient, and the analysis identifies the parameters that will affect experimental measurements of mass transfer through unsaturated rubble. 3 refs., 1 fig.

40417 (LBL–28430) **Release rates of radionuclides into dripping ground water.** Sadeghi, M.M.; Lee, W.W.L.; Pigford, T.H.; Chambre, P.L. Lawrence Berkeley Lab., CA (USA). Jan 1990. 5p. Sponsored by U.S. DOE Radioactive Waste Management. DOE Contract AC03-76SF00098. (CONF-900608–48: American Nuclear Society annual meeting, Nashville, TN (USA), 10-14 Jun 1990). Order Number DE90014308. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

Packages of high-level waste are to be emplaced in unsaturated tuff at the proposed Yucca Mountain repository. Each cylindrical waste package is separated from surrounding rock by a 2-cm air gap. A possible mechanism for release of radionuclides is the dripping of ground water onto waste packages. Drips are assumed to penetrate cracks in failed container and to dissolve radionuclides as the partly failed container fills and overflows. For this wet-drip scenario, with assumed constant drip rate, we have developed analytical solutions for the time-dependent release rates of radionuclides to the surrounding rock. Release rates have been calculated for key radionuclides. 7 refs., 3 figs.

40418 (NAGRA-NTB–86-11) **Exploratory boreholes Boettstein, Weiach, Riniken, Schafisheim, Kaisten, Leuggern: gas measurements.** Hinze, W. (GEMAG AG, Alberswil (Switzerland)); Jaeggi, K.; Schenker, F. Nationale Genossenschaft fuer die Lagerung Radioaktiver Abfaelle (NAGRA), Baden (Switzerland). Feb 1989. 158p. (In German). Available from Nagra, CH-5401 Baden, Switzerland.

The concentrations of hydrocarbon gas, carbon dioxide and hydrogen sulphide measured during the drilling of the Nagra boreholes are correlated with various drilling and drilling fluid parameters and presented in both graphic and tabular form. The Permocarboniferous in the Weiach borehole and the Muschelkalk in the Schafisheim borehole show clear positive gas anomalies. The hydrocarbon gas concentrations in the Crystalline were many times higher than those in the overlying sediments. Based on gas measurements (gas content and composition) for deep groundwaters and rock samples, it can be concluded for the Crystalline that gases penetrated from the rock formation through the borehole wall and into the drilling fluid and are also released from the crushed rock during the drilling process. Measurements of hydrogen and carbon isotopes on the gases from the Crystalline of the Weiach and Schafisheim boreholes indicate that the gases originated thermocatalytically from organic fossil material; their presence could therefore be explained by, e.g., migration from the Permocarboniferous. On the other hand, the higher deuterium and C-13 values in the Crystalline zone of Boettstein and Leuggern boreholes indicate rather that the hydrocarbon gases have an abiotic origin. (author) 3 figs., 2 tabs., 26 refs.

40419 (NUREG–1393) **The incineration of low-level radioactive waste: A report for the Advisory Committee on Nuclear Waste.** Long, S.W. Nuclear Regulatory Commission, Washington, DC (USA). Advisory Committee on Nuclear Waste. Jun 1990. 73p. Sponsored by Nuclear Regulatory Commission. Available from NTIS, PC A04/MF A01 - GPO; OSTI; INIS.

This report is a summary of the contemporary use of incineration technology as a method for volume reduction of LLW. It is intended primarily to serve as an overview of the technology for waste management professionals involved in the use or regulation of LLW incineration. It is also expected that organizations presently considering the use of incineration as part of their radioactive waste management programs will benefit by gaining a general knowledge of incinerator operating experience. Specific types of incineration technologies are addressed in this report, including designation of the kinds of wastes that can be processed, the magnitudes of volume reduction that are achievable in typical operation, and requirements for ash handling and off-gas filtering and scrubbing. A status listing of both US and foreign incinerators provides highlights of activities at government, industry, institutional, and commercial nuclear power plant sites. The Federal and State legislative structures for the regulation of LLW incineration are also described. 84 refs., 33 tabs.

40420 (ORNL/TM–11283) **Waste reduction plan for The Oak Ridge National Laboratory.** Schultz, R.M. Oak Ridge National Lab., TN (USA). Apr 1990. 48p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC05-84OR21400. Order Number DE90014203. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

The Oak Ridge National Laboratory (ORNL) is a multipurpose Research and Development (R&D) facility. These R&D activities generate numerous small waste streams. Waste minimization is

defined as any action that minimizes the volume or toxicity of waste by avoiding its generation or recycling. This is accomplished by material substitution, changes to processes, or recycling wastes for reuse. Waste reduction is defined as waste minimization plus treatment which results in volume or toxicity reduction. The ORNL Waste Reduction Program will include both waste minimization and waste reduction efforts. Federal regulations, DOE policies and guidelines, increased costs and liabilities associated with the management of wastes, limited disposal options and facility capacities, and public consciousness have been motivating factors for implementing comprehensive waste reduction programs. DOE Order 5820.2A, Section 3.c.2.4 requires DOE facilities to establish an auditable waste reduction program for all LLW generators. In addition, it further states that any new facilities, or changes to existing facilities, incorporate waste minimization into design considerations. A more recent DOE Order, 3400.1, Section 4.b, requires the preparation of a waste reduction program plan which must be reviewed annually and updated every three years. Implementation of a waste minimization program for hazardous and radioactive mixed wastes is sited in DOE Order 5400.3, Section 7.d.5. This document has been prepared to address these requirements. 6 refs., 1 fig., 2 tabs.

40421 (ORNL/TM–11434) **Analysis of Chemical Technology Division waste streams.** Abraham, T.J.; Donaldson, T.L.; Walker, A.B.; Cummins, R.L.; Reeves, M.E.; Hylton, T.D. Oak Ridge National Lab., TN (USA). Jul 1990. 43p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC05-84OR21400. Order Number DE90014701. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

This document is a summary of the sources, quantities, and characteristics of the wastes generated by the Chemical Technology Division (CTD) of the Oak Ridge National Laboratory. The major contributors of hazardous, mixed, and radioactive wastes in the CTD as of the writing of this document were the Chemical Development Section, the Isotopes Section, and the Process Development Section. The objectives of this report are to identify the sources and the summarize the quantities and characteristics of hazardous, mixed, gaseous, and solid and liquid radioactive wastes that are generated by the Chemical Technology Division (CTD) of the Oak Ridge National Laboratory (ORNL). This study was performed in support of the CTD waste-reduction program – the goals of which are to reduce both the volume and hazard level of the waste generated by the division. Prior to the initiation of any specific waste-reduction projects, an understanding of the overall waste-generation system of CTD must be developed. Therefore, the general approach taken in this study is that of an overall CTD waste-systems analysis, which is a detailed presentation of the generation points and general characteristics of each waste stream in CTD. The goal of this analysis is to identify the primary waste generators in the division and determine the most beneficial areas to initiate waste-reduction projects. 4 refs., 4 figs., 13 tabs.

40422 (PNL–6791) **Project test plan for runoff and erosion on fine-soil barrier surfaces and rock-covered side slopes.** Walters, W.H.; Hoover, K.A.; Cadwell, L.L. Pacific Northwest Lab., Richland, WA (USA). Jun 1990. 31p. Sponsored by U.S. DOE Energy Research. DOE Contract AC06-76RL01830. Order Number DE90013375. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Pacific Northwest Laboratory (PNL) and Westinghouse Hanford Company are working together to develop protective barriers to isolate near-surface radioactive waste. The purpose of the barriers is to protect defense wastes at the US Department of Energy's (DOE) Hanford Site from infiltration of precipitation, biointrusion, and surficial erosion for up to 10,000 years without the need for long-term monitoring, maintenance, or institutional control. The barriers will be constructed of layered earth and rock material designed to direct surface and groundwater pathways away from the buried waste. To address soil erosion as it applies to barrier design and long-term stability, a task designed to study this problem has been included in the Protective Barriers Program at PNL. The barrier soil-erosion task will investigate the ability of the soil cover and side slopes to resist the erosional and destabilizing processes from externally applied water. The study will include identification and field testing of the dominant processes contributing to erosion and barrier failure. The effects of rock mulches, vegetation cover on the top fine-grained soil surface, as well as the stability of rock armoring on the side slopes, will be evaluated. Some of the testing will include the effects of animal intrusion on barrier erosion, and these will be coordinated with other animal intrusion studies. 6 refs., 4 figs., 1 tab.

40423 (PNL–7374) **Water-table elevations on the Hanford Site, December 1989.** Newcomer, D.R.; McDonald, J.P. Pacific Northwest Lab., Richland, WA (USA). Jun 1990. 37p. Sponsored by U.S. DOE Management & Administration. DOE Contract AC06-76RL01830. Order Number DE90013374. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The Site Characterization and Assessment Section, Environmental Sciences Department, of the Pacific Northwest Laboratory (PNL) prepares water-table maps of the Hanford Site in southeastern Washington. Water levels in selected wells open to the unconfined aquifer on the Hanford Site are measured in June and December of each year. The purpose of these measurements is to determine the changes in the configuration of the water table to assess the physical impact of waste disposal on ground-water flow. Water-level measurements can be used to construct a water-table map that represents the elevation of the water-table surface. These maps can be used to infer general directions of ground-water flow, particularly in the upper part of the aquifer. In addition to water levels measured across the Hanford Site, water levels were also measured from four specific areas within Hanford. Included are areas around the decommissioned 216-U-10 Pond (U Pond), the 216-B-3 Pond (B-Pond), the 100-N Area and the 300 Area. 17 refs., 4 figs.

40424 (PNL–7394) **Experimental characterization of jet static forces impacting waste tank components: Final report.** Bamberger, J.A. (Pacific Northwest Lab., Richland, WA (USA)); Bates, J.M.; Waters, E.D. Pacific Northwest Lab., Richland, WA (USA). Jun 1990. 237p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC06-76RL01830. Order Number DE90013635. Available from NTIS, PC A11/MF A01 - OSTI; GPO Dep.

Westinghouse Hanford Company plans to install mixer pumps in doubleshell waste tanks to mobilize and suspend settled sludge to allow eventual retrieval for treatment and permanent storage. The mixer pumps produce high momentum, horizontally directed jets that impact and mobilize the sludge and mix it into slurry for removal. There is concern that the force of the jet may damage tank internal components in its path. Scaled experiments were conducted to characterize the velocity profiles of the floor jet and to quantify the drag coefficients and impact forces for three tank components: radiation dry well, air lift circulator, and steam coil. Jet impact forces were measured on the scaled models at a 4 to 1 range of hydraulically scaled flow rates and a scaled range of distances between discharge nozzle and test component. The test were designed to provide hydraulic similarity between test conditions and expected actual waste tank conditions by using equal Reynolds number the jet maximum velocity impacted the test component. Forces measured on the models were used to calculate expected forces on the full scale components. Correlations of force on the test article versus distance from the nozzle were derived for the radiation dry well and air lift circulator based on the velocity correlation and drag parameter. The force data were also used to derive equivalent drag parameters which accounted for component shape factors including variation of jet impact area on the test article with distance from the nozzle. 8 refs., 44 figs., 42 tabs.

40425 (SAND–89-3103) **Operations manual for reading VAK-3 ultrasonic seals using a data acquisition box.** Walker, J.E. Sandia National Labs., Albuquerque, NM (USA). May 1990. 30p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. Order Number DE90013644. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

As part of a Department of Energy/Commission of European Communities (DOE/CEC) cooperative program, Sandia National Laboratories was asked to develop a portable ultrasonic seal pattern reading system. The system consists of a data acquisition box (DAB), a mechanical reading head, and a portable IBM-compatible PC linked to the DAB by a serial RS-232C communication link. This manual focuses on the DAB subsystem. 8 refs., 13 figs., 8 tabs.

40426 (SAND–89-7056) **WIPP hydrology program, Waste Isolation Pilot Plant, southeastern New Mexico: Hydrologic Data Report No. 8: Parts A, H-11 multiped pumping and convergent-flow tracer test; B, P-14 air-lift pumping test; C, AEC-7 and D-268 slug tests; D, H-2b1, H-3b1, and H-3d slug and pulse tests; E, Hydraulic effects of air-intake shaft construction; F, Water-level data.** Stensrud, W.A. (INTERA, Inc., Austin, TX (USA)); Bame, M.A.; Lantz, K.D.; Palmer, J.B.; Saulnier, G.J. Jr. Sandia National Labs., Albuquerque, NM (USA); INTERA, Inc., Austin, TX (USA). Apr 1990. 717p. Sponsored by U.S. DOE Radioactive Waste Management. DOE Contract AC04-76DP00789. Order Number DE90014708. Available from NTIS, PC A99/MF A01; OSTI; INIS; GPO Dep.

Hydrologic Data Report No. 8 is organized into six parts, A, B, C, D, E, and F, and contains hydrologic-testing and water-level data from the Waste Isolation Pilot Plant (WIPP) site from May 1988 through August 1989. Part A describes a multipad-pumping and four-well convergent-flow tracer test at the H-11 hydropad. Part B describes a 72-hour airlift pumping test of the Culebra dolomite conducted at P-14 after the well was reperforated and acid treated. Part C describes slug-injection/withdrawal testing of the Culebra dolomite at wells AEC-7 and D-268. Part D describes slug- injection/withdrawal and pulse-injection/withdrawal testing of the Magenta dolomite at wells H-2bl and H-3bl, and of the Forty-niner Member at well H-3d. Part E contains data regarding hydraulic effects of drilling the Air-Intake Shaft pilot hole and up-reaming of the Air-Intake Shaft. Fluid-pressure responses were observed by transducers installed with a multipacker completion tool in well H-16, 56 ft from the shaft, and water-level responses were observed in other nearby wells. Part E also contains a log of shaft-construction activities. Part F contains water-level and fluid-pressure data collected from May 1988 through August 1989 in observation wells completed in the Dewey Lake Red Beds; the Forty-niner, Magenta Dolomite, Culebra Dolomite, and unnamed lower Members of the Rustler Formation; the contact between the Rustler and Salado Formations; and the Bell Canyon Formation at and near the WIPP site. 50 refs., 163 figs., 98 tabs.

40427 (SAND–90-0228) **Borehole closure and test zone volume determination program for brine-permeability test results within the Waste Isolation Pilot Plant underground facility.** Jensen, A.L. Sandia National Labs., Albuquerque, NM (USA). May 1990. 29p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. Order Number DE90013629. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

Until recently, hydrologic characterization in closed sections of boreholes at the Waste Isolation Pilot Plant (WIPP) has relied on measurements of pressure and temperature to establish the permeability of the host geological formations. There were no provisions for monitoring tool compliance and salt creep resulting from borehole closure. The new permeability test tool used to characterize the WIPP underground facility has been equipped with a series of sensors to measure the movement of the tool with respect to the borehole and borehole wall movement. A FORTRAN program can interpret the output data from each test and calculate the change in borehole radius, test zone length, and test zone volume. These values provide a correlation of fluid compressibility and tool compliance with the permeability results derived from the test data. 4 figs., 3 tabs.

40428 (SKB-TR–89-19, pp. 1:1-17) **Overview of the fracture zone project at Finnsjoen, Sweden.** Ahlbom, K. (Swedish Geological Co., Uppsala (Sweden)); Smellie, J.A.T. Swedish Nuclear Fuel and Waste Management Co., Stockholm (Sweden). Aug 1989. In *Characterization of fracture zone 2, Finnsjoen study-site.* Order Number DE90631518. Available from NTIS (US Sales Only), PC A11/MF A01; OSTI; INIS.

At the Finnsjoen site, central Sweden, a 100 m wide low angle fracture zone in granodiorite, Zone 2, has been studied by means of borehole investigations. This has included core and geophysical logging as well as hydraulic tests and groundwater sampling. Zone 2 was developed 1.6 - 1.7 Ga as a ductile shear zone at a depth of ca 10-15 km and repeated reactivation has occurred during Precambrian time and later. Today, the upper boundary of the zone is defined in nine boreholes at depths ranging from 100-295 m. Pumping tests have demonstrated that the upper part of the zone is highly water conductive with a transmissivity in excess of 10-3 m^2/s. From tracer tests the equivalent single fracture conductivity was calculated to be 0.03-0.2 m/s. This extremely high transmissivity and conductivity over such a large areal extent can be speculated to be the result of recent opening of Zone 2 during the last inland ice period. In-situ measurements of the natural groundwater flow show that the flow is high (67-90 m^3/m^2 x year) at the upper boundary of Zone 2, while near-stagnant conditions occur at the lower boundary, and in the relict saline water beneath the zone. Isotope data suggest a complex origin to the saline water. The hydraulic head measurements as well as the groundwater chemistry strongly suggest that the low angle Zone 2 acts as a hydraulic barrier preventing groundwater from percolating downward through the zone. These studies have helped to focus on repository safety assessment problems which hitherto had been oversimplified for the benefit of performance models. Furthermore, the results have shown that these low angle large-scale fracture zone are likely to be even more important controls than steep zones, when considering bedrock stability, rock stress regimes, and lateral groundwater flow patterns.

40429 (SKB-TR–89-19, pp. 2:1-43) **Geological setting and deformation history of a low angle fracture zone at Finnsjoen, Sweden.** Tiren, S.A. (Swedish Geological Co., Uppsala (Sweden)). Swedish Nuclear Fuel and Waste Management Co., Stockholm (Sweden). Aug 1989. In *Characterization of fracture zone 2, Finnsjoen study-site.* Order Number DE90631518. Available from NTIS (US Sales Only), PC A11/MF A01; OSTI; INIS.

In 1984 the Swedish Nuclear Fuel and Waste Management Co (SKB) initiated detailed investigation of the geological, geophysical, hydrological, and geochemical character of a fracture zone. For this purpose, a low angle, SSW-dipping fracture zone in a foliated granodiorite of Svecokarelian age (ca. 1.8 Ga), within the sub-Cambriam peneplain of northeastern Uppland, central, eastern Sweden, was identified and investigated by extensive drilling. The initial formation of this zone, which is estimated to have taken place ca. 1.7 Ga ago as a result of ductile deformation, was followed by shearing during ductilebrittle transitional conditions, and subsequently by brittle deformation. If formed as a thrust in a 20-30 km WNW-ESE trending strike-slip fault zone. The fracture zone is approx. 100 m wide with an anastomosing shear pattern and it is displaced by subvertical faults. Late reactivation of the zone has occurred preferentially in the upper part of the zone , which is now open, permitting water transport. The palaeo-flow paths, indicated by bedrock alteration and fracture infillings, show that the hydraulic flow system in the rock mass has become increasingly more restricted during geological time, and now dominantly occurs along descrete zones which were initiated more than 1.7 Ga ago, and since then have been repeatedly reactivated. The most intense penetrative fracturing, associated with hydrothermal activity, occurred more than 1.0 Ga ago. Fractures and fracture zones most likely to conduct water, i.e. forming transport pathways between a repository and the biosphere, will tend to be those with a long and complex tectonic history. (12 figs., 2 tabs., 44 refs.).

40430 (SKB-TR–89-19, pp. 3:1-56) **Hydraulic testing and modelling of a low-angle fracture zone at Finnsjoen, Sweden.** Andersson, J.E. (Swedish Geological Company, Uppsala (Sweden)); Ekman, L.; Nordqvist, R.; Winberg, A. Swedish Nuclear Fuel and Waste Management Co., Stockholm (Sweden). Aug 1989. In *Characterization of fracture zone 2, Finnsjoen study-site.* Order Number DE90631518. Available from NTIS (US Sales Only), PC A11/MF A01; OSTI; INIS.

The paper describes the hydraulic characteristics of a gently dipping fracture zone in crystalline rock at the Finnsjoen test site in Sweden. The information is derived from single-hole injection tests of different packer spacings, including very detailed test in 0.11 m sections in a few borehole segments. In addition, preliminary interference tests were carried out during drilling of boreholes BFI01. Subsequently, detailed interference tests were performed by pumping in different parts of the zone and monitoring pressure changes in multiple-section observation boreholes. The result of the hydraulic testing show that the fracture zone is composed of 2-5

narrow, highly conductive subzones in the boreholes, the uppermost subzone consistently located close to the upper boundary of the zone. This subzone can be correlated over several hundreds of metres along the zone. There are evidences of hydraulic anisotropy of the zone, both in the lateral and vertical directions. The interference tests showed that the fracture zone is delimited by semi-permeable boundaries, probably constituted by steeply dipping fracture zones. The results of the hydraulic testing were used to simulate the pressure responses obtained in the observation boreholes by a numerical model.

40431 (SKB-TR--89-19, pp. 4:1-51) **Groundwater flow conditions in a low angle fracture zone at Finnsjoen, Sweden.** Gustafsson, E. (Swedish Geological Company, Uppsala (Sweden)); Andersson, P. Swedish Nuclear Fuel and Waste Management Co., Stockholm (Sweden). Aug 1989. In *Characterization of fracture zone 2, Finnsjoen study-site.* Order Number DE90631518. Available from NTIS (US Sales Only), PC A11/MF A01; OSTI; INIS.

The performance and results of a series of hydraulic head measurement and differently designed tracer tests are described. A combined interpretation of the results are utilized to estimate the natural groundwater flow conditions in a low angle major fracture zone (Zone 2) investigated at the Finnsjoen study site, central eastern Sweden. The transport of labelled flushing water used during drilling of a cored borehole was utilized to determine hydraulic connections and estimations of hydraulic parameters. The breakthrough of tracer was monitored at a distance of 440 m from the injection point with a mean residence time of 37 days. In order to determine transport parameters of the fracture zone, a tracer test was performed in conjunction with an interference test. The hydraulic fracture conductivity, flow porosity, equivalent fracture width and dispersivity were calculated for three different tracer routes. Tracer was also used to detect any bypass around the packers during the interference test. Also described are a series of groundwater flow determinations using the point dilution technique in packed-off borehole sections, carried out under natural gradient conditions. The groundwater head measurements indicated that a pressure gradient from high to low exists between the adjacent rocks and Zone 2; where Zone 2 is located closer to the ground surface the opposite situation prevails. The upper highly conductive part of the zone was found to have high natural flow rates, while in the lower highly conductive part the groundwater flow rates were very low, close to the rate of molecular diffusion. (18 figs., 12 tabs., 25 refs.).

40432 (SKB-TR--89-19, pp. 5:1-37) **Hydrochemical investigations at Finnsjoen, Sweden.** Smellie, J.A.T. (Swedish Geological Company, Uppsala (Sweden)); Wikberg, P. Swedish Nuclear Fuel and Waste Management Co., Stockholm (Sweden). Aug 1989. In *Characterization of fracture zone 2, Finnsjoen study-site.* Order Number DE90631518. Available from NTIS (US Sales Only), PC A11/MF A01; OSTI; INIS.

Groundwater collected from in and around a highly conductive low angle fractured zone in crystalline rock have been studied in relation to drilling and sampling methods, water quality, and the hydrogeochemical interpretation of the groundwater. Air-flush percussion drilling was demonstrated to be efficient down to 200-250 m; at greater depths, large amounts of drilling debris and increasing groundwater contamination from air dissolution become apparent. A stepwise drilling/sampling protocol using water-flush rotary drilling, in combination with water analysis carried out on site using a mobile laboratory, is recommended for future studies. The chemistry of the Finnsjoen groundwater show a sharp contact between saline and non-saline compositions, this contact corresponding to a highly conductive low angle fracture zone (Zone 2). This zone is therefore a horizon along which groundwater of contrasting age and chemistry come into contact and partially mix with one another. This mixing has produced a highly supersaturated water resulting in the precipitation of calcite. This is most evident in fractures within the more conductive, upper part of Zone 2, thus partly forming a seal between the two groundwater environments. Comparison of the Finnsjoen saline water with other saline environments, particularly in the Fennoscandian Shield, has shown that the groundwater are dominantly marine in origin, but with clear modifications resulting from water/rock interaction processes. Apparent radiocarbon ages range from 9000-15000 years in those waters recording below detection levels of tritium. These ages are considered too young and this is thought to have resulted from mainly carbon-14 dilution caused by groundwater mixing during the Holocene, when large quantities of glacial meltwater were available. This mixing process is also supported by the oxygen-18 data. (10 figs., 3 tabs., 31 refs.).

40433 (SKB-TR--89-19, pp. 6:1-23) **Effects of gas-lift pumping on hydraulic borehole conditions at Finnsjoen, Sweden.** Andersson, J.E. (Swedish Geological Company, Uppsala (Sweden)); Andersson, P.; Gustafsson, E. Swedish Nuclear Fuel and Waste Management Co., Stockholm (Sweden). Aug 1989. In *Characterization of fracture zone 2, Finnsjoen study-site.* Order Number DE90631518. Available from NTIS (US Sales Only), PC A11/MF A01; OSTI; INIS.

The recorded volumes of flushing water used during the drilling of cored boreholes, and the amounts recovered at the surface, have been used to estimate the potential quantities of flushing water and drilling debris injected into fractures. The results show that significant amounts of flushing water and drilling debris may be injected into fractures during drilling. For cored boreholes penetrating major fracture zones, only about 7-8% of the total volume of flushing water used was recovered at the surface. A total loss of flushing water occurred in all boreholes during penetration of these fracture zone. The recovered amounts of drilling debris were also low. Higher percentages of drilling debris were recovered from the air-flush percussion boreholes but, on the other hand, larger total amounts of debris were lost to the rock. During gas-lift pumping in borehole KFI10, only very small estimated amounts of the flushing water (3-4%) and drilling debris (approx. 1%) lost to the rock, were recovered. The gas-lift pumping also had a minor influence on the borehole hydraulic parameters calculated from hydraulic tests before and after pumping. (7 figs., 3 tabs., 12 refs.).

40434 (WHC-EP--0173) **An experimental investigation of copper-Zircaloy interactions under possible tuff repository conditions.** Smith, H.D. Westinghouse Hanford Co., Richland, WA (USA). May 1990. 50p. Sponsored by U.S. DOE Radioactive Waste Management. DOE Contract AC06-87RL10930. Order Number DE90014339. Available from NTIS, PC A04/MF A01; OSTI; INIS; GPO Dep.

As part of its evaluation of copper and copper alloys for use as a container material for spent fuel, the Nevada Nuclear Waste Storage Investigations Project sponsored this experimental study to determine if the presence of copper would influence the corrosion rate of Zircaloy spent fuel cladding under possible tuff repository conditions. The experiment consisted of exposing copper/Zircaloy clad spent fuel packages to two different environments for up to 9 months. Detailed evaluation of the cladding via metallography, electron probe microanalysis, scanning electron microscopy with microanalysis, and Auger electron spectroscopy/ion milling to chemically profile the surface film failed to provide an evidence of copper-enhanced corrosion of the Zircaloy cladding. The difference in thickness of the oxide films between the 2-month and 5-month experiments, and the 2-month and 9-month experiments as indicated by the time to ion mill through the films, was on the order of 50 Å, and 100 Å, respectively, indicating a very low rate of film growth during the experiments. 20 refs., 21 figs., 8 tabs.

40435 (WHC-EP--0182-23) **Tank farm surveillance and waste status summary report for February 1990.** Hanlon, B.M. Westinghouse Hanford Co., Richland, WA (USA). Apr 1990. 42p. Sponsored by U.S. DOE Office of Environmental Restoration and Waste Management. DOE Contract AC06-87RL10930. Order Number DE90013647. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This report is Westinghouse Hanford Company's official inventory for high-level radioactive waste stored in underground tanks at the Hanford Site. Data that depict the status of stored, high-level waste and tank vessel integrity are contained within the report. the intent of the report is to provide data on each of the existing 177 underground waste tanks and provide supplemental information regarding tank anomalies and ongoing investigations.

40436 (WHC-EP–0223) **Stored, contact-handled transuranic waste characterization at the Hanford Site.** Anderson, B.C. Westinghouse Hanford Co., Richland, WA (USA). Dec 1989. 40p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC06-87RL10930. Order Number DE90013646. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This document presents the Plan for characterizing the contact-handled transuranic (CH-TRU) waste in storage at the Hanford Site. This Program is being conducted to accomplish the following: provide CH-TRU baseline information for design of waste treatment in the Waste Receiving and Processing (WRAP) Facility, provide information for extending the storage of CH-TRU solid waste beyond the facility 20-yr design period, obtain information to allow the planning of full-scale retrieval, and establish the nondestructive examination and assay requirements (NDE/NDA) for the WRAP Facility. The program will be performed in three phases. The first phase will be to characterize the waste based on existing records. The second phase will consist of retrieving a random sample and characterizing the waste based on NDE/NDA examinations. This phase will also provide data to justify extending the time that CH-TRU waste can be stored. The third phase, if required, will characterize the waste based on opening drums and examining the contents in a glovebox. The examination would include segregation, weighing, chemical analysis, and inspections required to further quantify the waste attributes. 7 refs., 1 tab.

40437 (WHC-EP–0225) **Contact-handled transuranic waste characterization based on existing records.** Anderson, B.C.; Anderson, J.D.; Demiter, J.A.; Duncan, D.R.; McCann, D.C. Westinghouse Hanford Co., Richland, WA (USA). Feb 1990. 171p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC06-87RL10930. Order Number DE90013645. Available from NTIS, PC A08/MF A01 - OSTI; GPO Dep.

This report contains the results of characterizing the retrievably stored, contact-handled transuranic (CH-TRU) waste based on existing records. This report is the first comprehensive analysis of these records. A history of the methods used in storing the transuranic waste and in determining how the data was accumulated for entry into the Richland-Solid Waste Information Management System (R-SWIMS) is also described. Data from the R-SWIMS have been the primary source of information in characterizing the waste contents. Supporting documents and interviews with knowledgeable people provide the basis for documenting the history of storage practices. The storage conditions will be investigated further to ensure that a representative statistical sample is obtained for the second phase of this characterization program 12 refs., 19 figs., 46 tabs.

40438 (WHC-EP–0250-Draft-Rev.B-App.) **Hanford Waste Vitrification Plant preliminary safety analysis report: Appendix.** Westinghouse Hanford Co., Richland, WA (USA). Jul 1990. 626p. Sponsored by U.S. DOE Office of Environmental Restoration and Waste Management. DOE Contract AC06-87RL10930. Order Number DE90014060. Available from NTIS, PC A99/MF A01 - OSTI.

This document contains the appendix for Chapter 6 of the "Hanford Waste Vitrification Plant Preliminary Safety Analysis Report." This report contains information on activities at the proposed Vitrification Plant at Hanford Reservation. Topics include material balance tables, process flow schematics, and piping and instrumentation diagrams. (KJD)

40439 (WHC-EP–0250-Draft-Rev.B-Vol.1) **Hanford Waste Vitrification Plant Preliminary Safety Analysis Report: Draft, Revision B: Volume 1.** Westinghouse Hanford Co., Richland, WA (USA). Jul 1990. 523p. Sponsored by U.S. DOE Office of Environmental Restoration and Waste Management. DOE Contract AC06-87RL10930. Order Number DE90013935. Available from NTIS, PC A22/MF A01 - OSTI; GPO Dep.

This document comprises the safety analysis report for the proposed vitrification plant at the Hanford Reservation. Topics discussed in Volume 1 include a safety analysis, site characterization, and principal design criteria. (KJD)

40440 (WHC-EP–0250-Draft-Rev.B-Vol.2) **Hanford Waste Vitrification Plant preliminary safety analysis report: Draft, Revision B, Volume 2.** Westinghouse Hanford Co., Richland, WA (USA). Jul 1990. 474p. Sponsored by U.S. DOE Office of Environmental Restoration and Waste Management. DOE Contract AC06-87RL10930. Order Number DE90013936. Available from NTIS, PC A20/MF A01 - OSTI; GPO Dep.

This volume of the Hanford Waste Vitrification Project (HWVP) preliminary safety analysis report (PSAR) provides descriptive information on the buildings, structures, and design features for the HWVP. It emphasizes features that serve a confinement and safety function. Special design features employed to withstand environmental and accident forces are also discussed. Also discussed are the safety analysis of the HWVP facility, details on the characteristics of the Hanford Site including geology, meteorology, and hydrology, the design criteria for the HWVP facility, details on the process systems, including process flow diagrams, and a discussion of physical and chemical data for the HWVP. 51 refs., 51 figs., 43 tabs.

40441 (WHC-EP–0250-Draft-Rev.B-Vol.3) **Hanford Waste Vitrification Plant preliminary safety analysis report: Draft, Revision B, Volume 3.** Westinghouse Hanford Co., Richland, WA (USA). Jul 1990. 433p. Sponsored by U.S. DOE Office of Environmental Restoration and Waste Management. DOE Contract AC06-87RL10930. Order Number DE90013937. Available from NTIS, PC A19/MF A01 - OSTI; GPO Dep.

This volume provides a detailed description of Hanford Waste Vitrification Plant (HWVP) process systems and selected process support systems. Items of safety analysis concern related to the process and process support systems. Items of safety analysis concern related to the process and process support systems, waste management and the confinements of radioactive and nonradioactive wastes generated during the course of the processing operations at HWVP, and the HWVP design features and methods for protecting personnel an the public from radiation during operations. 66 refs., 67 figs., 58 tabs., (KJD)

40442 (WHC-EP–0250-Draft-Rev.B-Vol.4) **Hanford Waste Vitrification Plant preliminary safety analysis report: Draft, Revision B: Volume 4.** Westinghouse Hanford Co., Richland, WA (USA). Jul 1990. 395p. Sponsored by U.S. DOE Office of Environmental Restoration and Waste Management. DOE Contract AC06-87RL10930. Order Number DE90013938. Available from NTIS, PC A17/MF A01 - OSTI; GPO Dep.

This document contains five chapters in activities at the proposed vitrification plant at the Hanford Reservation. Chapter topics include waste confinement and management, health protection, accident safety analysis, operational safety requirements, and quality assurance. (KJD)

40443 (WHC-EP–0268) **CURE: Clean use of reactor energy.** Westinghouse Hanford Co., Richland, WA (USA). May 1990. 197p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC06-87RL10930. Order Number DE90013614. Available from NTIS, PC A09/MF A01; OSTI; INIS; GPO Dep.

This paper presents the results of a joint Westinghouse Hanford Company (Westinghouse Hanford)-Pacific Northwest Laboratory (PNL) study that considered the feasibility of treating radioactive waste before disposal to reduce the inventory of long-lived radionuclides, making the waste more suitable for geologic disposal. The treatment considered here is one in which waste would be chemically separated so that long-lived radionuclides can be treated using specific processes appropriate for the nuclide. The technical feasibility of enhancing repository performance by this type of treatment is considered in this report. A joint Westinghouse Hanford-PNL study group developed a concept called the Clean Use of Reactor Energy (CURE), and evaluated the potential of current technology to reduce the long-lived radionuclide content in waste from the nuclear power industry. The CURE process consists of three components: chemical separation of elements that have significant quantities of long-lived radioisotopes in the waste, exposure in a neutron flux to transmute the radioisotopes to stable nuclides, and packaging of radionuclides that cannot be transmuted easily for storage or geologic disposal. 76 refs., 32 figs., 24 tabs.

40444 (WHC-EP–0318) **Hanford Site protective barrier development program: Fiscal year 1989 highlights.** Wing, N.R. (ed.) (Westinghouse Hanford Co., Richland, WA (USA)); Gee,

G.W. (ed.). Westinghouse Hanford Co., Richland, WA (USA). Mar 1990. 52p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC06-87RL10930. Order Number DE90014400. Available from NTIS, PC A04/MF A01 - OSTI; GPO Dep.

Protective barrier and warning marker systems are being developed to isolate radioactive wastes disposed near the earth's surface at the Hanford Site. The protective barrier and warning marker systems use engineered layers of natural materials to create an integrated structure with redundant protective features. Natural construction materials have been selected to optimize barrier performance and longevity. The objectives of current designs are to use natural materials to develop a protective barrier and warning marker system that isolates wastes for up to 10,000 yr by limiting water drainage; reducing the likelihood of plant, animal, and human intrusion; controlling the exhalation of noxious gases; and minimizing erosion-related problems. 2 refs., 29 figs.

40445 (WHC-EP–0333-Draft) **Single-shell tank systems analysis description: Draft.** Garfield, J.S. Westinghouse Hanford Co., Richland, WA (USA). Jun 1990. 26p. Sponsored by U.S. DOE Office of Environmental Restoration and Waste Management. DOE Contract AC06-87RL10930. Order Number DE90014062. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This document provides an overview of the systems analysis work planned for closure of six operable units that make up the single- shell tank (SST) system. The facilities to be closed are defined in Appendix C of the Hanford Federal Facility Agreement and Consent Order (Tri-Party Agreement). The operable units include 149 SSTs and other ancillary units such as diversion boxes, catch tanks, spills, cribs, valve pits, vaults, and septic tanks. The significant Tri- Party Agreement milestones pertaining to SSTs are summarized in Appendix A. 12 refs., 5 figs.

40446 (WHC-EP–0338-Draft) **Functional requirements baseline for the closure of single-shell tanks: Draft.** Boomer, K.D.; Garfield, J.S.; Giese, K.A.; Higley, B.A.; Layman, J.S.; Boldt, A.L.; Croskrey, N.R.; Golberg, C.E.; Johnson, L.J.; Parazin, R.J. Westinghouse Hanford Co., Richland, WA (USA). Jun 1990. 137p. Sponsored by U.S. DOE Office of Environmental Restoration and Waste Management. DOE Contract AC06-87RL10930. Order Number DE90014061. Available from NTIS, PC A07/MF A01 - OSTI; GPO Dep.

This document compiles a baseline of the functional requirements that will guide the conceptual design and development of single-shell tank (SST) system closure facilities. The functional requirements baseline is part of a larger systems engineering approach. These requirements will provide a framework for closure alternative selection. The Westinghouse Hanford Company (Westinghouse Hanford) will update this baseline to incorporate new technology as it is identified, developed, and demonstrated and as the range of alternatives is narrowed. 39 refs., 21 figs., 12 tabs.

40447 (WHC-MR–0060) **Temperature data.** Welty, R.K. Westinghouse Hanford Co., Richland, WA (USA). Nov 1989. 152p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC06-87RL10930. Order Number DE90014397. Available from NTIS, PC A08/MF A01 - OSTI.

This report contains temperature data for tanks at Hanford Reservation for November 1989. (KJS)

40448 (WHC-SA–0646) **Long-term management of Hanford Site single-shell tank waste.** Opitz, B.E.; Owens, K.W.; Hall, V.W. Westinghouse Hanford Co., Richland, WA (USA). May 1990. 16p. Sponsored by U.S. DOE Office of Environmental Restoration and Waste Management. DOE Contract AC06-87RL10930. (CONF-9006240–1: American society for testing and materials symposium on water in the 1990's: meeting new challenges, Denver, CO (USA), 11-14 Jun 1990). Order Number DE90014063. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Since the 1940's, defense-related nuclear waste has been stored in single-shell tanks on the Hanford Site. The radioactive components of the waste are regulated in accordance with the Atomic Energy Act of 1954. The hazardous components are regulated in accordance with the Resource Conservation and Recovery Act as implemented by the Washington State Dangerous Waste Regulations. This report provides a background of the single-shell tank waste and a description of the initial studies underway to characterize the material that will provide information to support performance assessment studies and regulatory compliance while minimizing unnecessary radiation doses to workers. 13 refs., 2 figs., 2 tabs.

40449 (WHC-SA–0657) **Treatment and storage of high-level radioactive waste in the Defense Waste Processing Facility and the Hanford Waste Vitrification Plant.** Swenson, L.D. (Westinghouse Hanford Co., Richland, WA (USA)); Wolfe, B.A.; Gentilucci, J.A. Westinghouse Hanford Co., Richland, WA (USA). Jun 1989. 5p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC06-87RL10930. (CONF-9009128–1: Nuclear congress and technology/industry expo, Geneva (Switzerland), 23-28 Sep 1990). Order Number DE89014960. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

The Defense Waste Processing Facility (DWPF) and the Hanford Waste Vitrification Plant (HWVP) projects will provide similar facilities for producing vitrified high-level defense waste in scaled, stainless-steel canisters. The respective production sites will also provide interim storage for at least some of the canistered waste pending availability of a permanent repository. The canistered waste form will be produced under stringent controls to support final placement in the US Nuclear Regulatory Commission's (NRC) licensed, deep geological repository.

40450 (WHC-SA–0825) **Hanford Waste Vitrification Plant: The project and process systems.** Swenson, L.D.; Miller, W.C.; Smith, R.A. Westinghouse Hanford Co., Richland, WA (USA). Jun 1990. 9p. Sponsored by U.S. DOE Office of Environmental Restoration and Waste Management. DOE Contract AC06-87RL10930. (CONF-900608–49: American Nuclear Society annual meeting, Nashville, TN (USA), 10-14 Jun 1990). Order Number DE90014341. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

Construction of the Hanford Waste Vitrification Plant (HWVP) Project is scheduled to start on the Hanford Reservation in southeastern Washington State in 1991. The Project will immobilize liquid high-level and transuranic (TRU) defense wastes stored there and permit ultimate disposal of the waste in the nation's commercial deep geological repository. This document discusses the project and process systems. The HWVP represents the third phase of the US Department of Energy (DOE) activities that are focused on the permanent disposal of high-level radioactive waste, building on the experience of the Defense Waste Processing Facility (DWPF) at the Savannah River Site, South Carolina, and of the Waste Valley Demonstration Project (WVDP), New York.

40451 (WHC-SA–0826) **(Alpha,n) reactions in vitrified waste.** Goldberg, H.J. Westinghouse Hanford Co., Richland, WA (USA). May 1990. 7p. Sponsored by U.S. DOE Office of Environmental Restoration and Waste Management. DOE Contract AC06-87RL10930. (CONF-9009116–3: Spectrum '90: radioactive waste technologies, decontamination, decommissioning and hazardous wastes, Knoxville, TN (USA), 30 Sep - 4 oct 1990). Order Number DE90011520. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

A package consisting of radioactive wastes immobilized in a glass matrix must have adequate shielding in order to be handled safely. In addition to the gamma radiation from the decay of the fission products and the neutron radiation from the spontaneous fission of any actinides present, the effects of alpha-emitting radionuclides must be considered. These alpha particles will interact with the light elements present in the matrix and give rise to neutron and gamma radiation over and above that arising from the waste directly. The main thrust of this paper is to calculate the (alpha,n) contribution to the neutron flux and spectrum. 5 refs., 2 tabs.

40452 **Slurry-fed ceramic melter: A broadly accepted system to vitrify high-level waste.** Chapman, C.C. (Pacific Northwest Lab., Richland, WA (USA)); McElroy, J.L. pp. 119-128 of High level radioactive waste and spent fuel management: Volume 2. Slate, S.C.; Kohout, R.; Suzuki, A. American Society of Mechanical Engineers, New York, NY (USA) (1989). DOE Contract AC06-76RL01830. (CONF-891006–: Joint international waste management conference, Kyoto (Japan), 23-28 Oct 1989).

Slurry (or liquid)-fed ceramic melters (LFCM) have been chosen for vitrifying liquid high-level radioactive waste (HLW) in projects around the world: three in the U.S., two in Japan, one in West Germany, and one in Belgium. This paper summarizes the experience with this technology, which has proven adaptable to the broadest spectrum of wastes and throughputs. The generic technical issues of process and product requirements are reviewed, including differences among wastes and their processing challenges, such as throughput, elemental solubilities, corrosiveness, and preferred methods.

40453 Application of stochastic dynamic simulation to waste from qualification for the HWVP vitrification process. Kuhn, W.L. (Pacific Northwest Lab., Richland, WA (US)); Westsik, J.H. pp. 187-192 of High level radioactive waste and spent fuel management: Volume 2. Slate, S.C.; Kohout, R.; Suzuki, A. American Society of Mechanical Engineers, New York, NY (USA) (1989). DOE Contract AC06-76RL01830. (CONF-891006--: Joint international waste management conference, Kyoto (Japan), 23-28 Oct 1989).

Processing steps during the conversion of high-level nuclear waste into borosilicate glass in the Hanford waste vitrification plant are being simulated on a computer by addressing transient mass balances. The results are being used to address the U.S. Department of Energy's waste form qualification requirements. The simulation addresses discontinuous (batch) operations and perturbations in the transient behavior of the process caused by errors in measurements and control actions. A collection of tests, based on process measurements, is continually checked and used to halt the simulated process when specified conditions are met. An associated set of control actions is then implemented in the simulation. The results for an example simulation are shown.

40454 Bidirectional draining pore-fluid vessel. Prizio, J. To Department of the Interior, Washington, DC. USA Patent Application 7-490,898. 6 Mar 1990. 7p. Available from NTISPC N03/MF A01.

This Government-owned invention available for U.S. licensing and, possibly, for foreign licensing. Copy of application available NTIS.

The invention pertains to an apparatus for extracting pore fluids from porous solids to determine the suitability for a potential repository to store high-level radioactive wastes. Pore fluids are necessary for chemical analysis to help characterize the local hydrologic system and to evaluate the potential interaction of pore gas and water with waste canisters. The principal utility of the bidirectionally draining pore-fluid extraction vessel is that it extracts pore fluids from porous solids through a combination of one-dimensional mechanical compression and inert gas injection.

0530 Environmental Aspects

Refer also to citation(s) 40426, 40444, 40449, 41625

40455 (BARC–1477) **Environmental radiation levels around Nuclear Fuel Complex, Hyderabad during 1981-1988.** Mehta, Navnit (Bhabha Atomic Research Centre, Bombay (India). Health Physics Div.); Lakshmanan, A.R.; Kathuria, S.P.; Nambi, K.S.V. Bhabha Atomic Research Centre, Bombay (India). 1989. 24p. Order Number DE90633877. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

This report presents environmental radiation monitoring results around Nuclear Fuel Complex (NFC) at Hyderabad for the period, 1981-'88. During 1981-'83 only indoor radiations were monitored at 12 locations in the region of about 15 km. radius around NFC plant. However, during 1984-'88 both indoor and outdoor monitoring was done in a standardised manner at 8 locations. In this routine monitoring programme, environmental thermoluminescent dosimeters were used in quarterly integrating cycles. The average outdoor natural radiation level around NFC during 1984-'88 is found to be 227 $\pm$ 34 (σ) mR/y, which is the highest among the various sites in the country where DAE units are located. Such a high level of natural background radiation in and around Hyderabad is due to granitic terrains which normally have significant amounts of primordial radioactivity. The indoor to outdoor radiation ratio is found to be 1.35 $\pm$ 0.1 (σ). Application of this ratio on all the available indoor radiation monitoring results of 1981-'88 gives an estimate of 230 $\pm$ 26 mR/y as the average outdoor radiation level, and this is in very close agreement with the directly measured value mentioned earlier. The temporal variations seen in the quarterly results of each location have been tested for Normal and Log-Normal distributions and found to yield satisfactory correlations, although the plots reveal slight skewness; the latter however, could not be attributed to the NFC operations. (author). 7 refs., 4 tabs., 12 figs.

40456 (NRPB-R–231) **Radiological impact of routine discharges from UK civil nuclear sites.** Lawson, G.; Cooper, J.R.; McColl, N.P. National Radiological Protection Board, Chilton (UK). 1990. 62p. Available from H.M. Stationery Office, London, price Pound 6.00.

Calculations show that the radiation exposure of the population of Europe over the next 500 years (collective dose commitment truncated at 500 years) from UK civil nuclear discharges peaked at around 700 man Sv for discharges in 1975. Since then a steady reduction is seen, to an estimated 60 man Sv for 1986 discharges. The corresponding exposure of the UK population is around 300 man Sv for 1975 discharges and 17 man Sv for 1986. This reduction is largely due to reduced levels of radioactivity in liquid discharges from Sellafield. Calculated doses to typical individuals living near nuclear sites are low. Those from atmospheric discharges range from a few nanosieverts to a few microsieverts. Those from liquid discharges range from a few tens of picosieverts to about half a millisievert, which, with the exception of doses around Sellafield in the 1970s and early 1980s, are generally much smaller than doses arising from the consumption of natural radionuclides in seafoods. (author).

40457 (PB–90-868951/XAB) **Uranium mining and milling environmental studies. February 1984-May 1987 (A Bibliography from the NTIS data base). Report for February 1984-May 1987.** National Technical Information Service, Springfield, VA (USA). May 1990. 183p. Available from NTISPC N01/MF N01.

See also PB–90-868969.

This bibliography contains citations concerning environmental and social aspects of uranium mining, milling, and ore treatment. Environmental and social aspects include air and water pollution, public health, occupational safety, land reclamation, and waste disposal. The citations refer to monitoring and control of contaminants, and environmental surveys and impact statements for specific areas in the vicinity of mining and ore treatment facilities. There are also references to health studies performed on miners and millworkers. (This updated bibliography contains 349 citations, none of which are new entries to the previous edition.)

40458 (PB–90-868969/XAB) **Uranium mining and milling environmental studies. June 1987-May 1990 (A Bibliography from the NTIS data base). Report for June 1987-May 1990.** National Technical Information Service, Springfield, VA (USA). May 1990. 105p. Available from NTISPC N01/MF N01.

Supersedes PB–87-860755. See also PB–90-868951.

This bibliography contains citations concerning environmental and social aspects of uranium mining, milling, and ore treatment. Environmental and social aspects include air and water pollution, public health, occupational safety, land reclamation, and waste disposal. The citations refer to monitoring and control of contaminants, and environmental surveys and impact statements for specific areas in the vicinity of mining and ore treatment facilities. There are also references to health studies performed on miners and millworkers. (This updated bibliography contains 176 citations, all of which are new entries to the previous edition.)

0540 Health and Safety

Refer also to citation(s) 40414, 40439, 40441, 40442, 40457, 40458, 41699, 41702, 41707

40459 (DOE/OR/20722–193.1-Draft) **Work plan for the remedial investigation/feasibility study-environmental impact statement for the Maywood site, Maywood, New Jersey: Draft.** Argonne National Lab., IL (USA); Bechtel National, Inc., San Francisco, CA (USA). Jul 1990. 187p. Sponsored by U.S. DOE Nuclear

Energy. DOE Contract W-31109-ENG-38 ;AC05-81OR20722. Order Number DE90014727. Available from NTIS, PC A09/MF A01; OSTI; INIS; GPO Dep.

This work plan has been prepared to document the scoping and planning process performed by the US Department of Energy (DOE) to support remedial action activities at the Maywood site located in northern New Jersey in the boroughs of Maywood and Lodi and the township of Rochelle Park. Remedial action at the Maywood site is being planned as part of DOE's Formerly Utilized Sites Remedial Action Program. The DOE is responsible for controlling the release of all contaminants from the site. Under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), a remedial investigation/feasibility study (RI/FS) must be prepared to support the decision-making process for evaluating remedial action alternatives. This work plan contains a summary of information currently known about the Maywood site, presents a conceptual site model that identifies potential routes of human exposure to site contaminants, identifies data gaps, and summarizes the process and proposed studies that will be used to fill the data gaps. In addition, DOE activities must be conducted in compliance with the National Environmental Policy Act (NEPA), which requires consideration of the environmental consequences of a proposed action as part of its decision-making process. It is DOE policy to integrate the requirements of the CERCLA and NEPA processes for remedial actions at sites for which it has responsibility. This work plan also describes the approach that will be used to evaluate potential remedial action alternatives and includes a description of the organization, project controls, and task schedules that will be employed to fulfill the requirements of both CERCLA and NEPA. 150 refs., 26 figs., 17 tabs.

40460 (DOE/OR/21548–106) **Engineering evaluation/cost analysis for the proposed management of contaminated water impounded at the Weldon Spring chemical plant area.** MacDonell, M.M. (Argonne National Lab., IL (USA)); Maxey, M.L.; Peterson, J.M.; Joya, I.E. Argonne National Lab., IL (USA). Jul 1990. 199p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract W-31109-ENG-38 ;AC05-86OR21548. Order Number DE90013622. Available from NTIS, PC A10/MF A01; OSTI; INIS; GPO Dep.

This engineering evaluation/cost analysis (EE/CA) report has been prepared to support the proposed removal action for managing contaminated surface waters impounded at the chemical plant area of the Weldon Spring site, located near Weldon Spring, Missouri. The US Department of Energy is responsible for cleanup activities at the site under its Surplus Facilities Management Program (SFMP). The major goals of SFMP are to eliminate potential hazards to human health and the environment that are associated with contamination at SFMP sites and to make surplus real property available for other uses, to the extent possible. The objectives of this EE/CA report are to identify the cleanup as a removal action, document the selection of a response that will mitigate the potential release of radioactive or chemical contaminants from the impounded waters into the nearby environment, and address environmental impacts associated with the proposed action. 41 refs., 8 figs., 8 tabs.

40461 (HW–69988-Rev.2) **Design limits for radioactive waste disposal from the Fuels Recycle Pilot Plant: Revision 2.** Backman, G.E. General Electric Co., Richland, WA (USA). Hanford Atomic Products Operation. 14 Sep 1962. 8p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC06-76RL01830. Order Number DE90014024. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The Fuel Recycle Pilot Plant (FRPP) will be a research and development facility which will demonstrate the feasibility of fabricating and/or reconstituting fuel elements from partially decontaminated fissionable material. This material will contain various combinations of fission product spectrums of U^{235}, Pu^{239} and Pu^{241}. Some of the shorter lived radionuclides will present containment and disposal problems which have not been experienced by the existing facilities which process irradiated uranium from the production reactors. In addition, some of the proposed processes will be entirely different from those with which HAPO has had previous experience. Because of the close proximity of farming districts to the 300 Area, large releases of radioactive materials in the gaseous effluents of the various facilities could cause considerable radiation exposure to people in this area. Those nuclides which can cause radiation exposure through the ecological chains are of particular concern. The intent of this document is to present design limits for the various effluents which would keep radiation exposure to personnel, both on and off plant, within acceptable bounds. All of the suggested limits were derived on the basis of radiation exposure received at the nearest logical point of uptake of the radionuclides.

0550 Safeguards, Inspection, and Accountability

Refer also to citation(s) 40391, 40393, 40425, 40470, 41272, 41274

40462 (EGG–10617-6070) **PC-based simulations: Effective, low-cost, alternative training in tactical decision-making for the US Department Of Energy's protective forces.** Stoudenmire, P.F. EG and G Energy Measurements, Inc., Albuquerque, NM (USA). Kirtland Operations. [1990]. 3p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC08-88NV10617. (CONF-9009172–1: Close combat light simulations technology conference, Albuquerque, NM (USA), 17-20 Sep 1990). Order Number DE90012583. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Simulation is one of the most effective training methodologics for helping students transfer classroom knowledge to practical understanding. Simulations encourage a student to apply newly learned facts to a credible problem faced in the real world. In applying knowledge, the student gains an operational understanding of the task and confidence that the task can be performed under the pressures of reality. The power of simulation as a teaching tool does not have to be argued to this group. The dilemma is, how can simulations be integrated into more courses? The promise of computer simulations has sometimes not been realized because these simulations typically have been thought of as appropriate only for elaborate, complex projects, requiring a high cost of development and implementation. Sophisticated simulations typically require 500 manhours of development time per course hour of instruction. Because of the large amount of data and the need to process this data quickly these simulations usually need the processing power of a mini computer. A training center with ten student workstations could cost over $750,000 for the computers alone. With costs like these simulations only meet an effective cost/benefit ratio for training objectives that are extremely costly or hazardous to achieve with other methods. However, if a simulation could be delivered on a personal computer, the cost for the training center would be reduced to $35,000 and the simulation would be accessible to more trainees. And, if the time for development could be reduced to 60 manhours per course hour, development costs would be close to other teaching methodologies and simulations could be effectively integrated into more courses. These were the objectives when the Tactical Assessment, Deployment and Decision making (TADD) simulation was proposed. How these objectives were achieved is the subject of this paper.

40463 (SAND–90-0668C) **A Visual Artificially Intelligent Surveillance System to protect against the Insider threat.** Kurtz, V.I. Sandia National Labs., Albuquerque, NM (USA). [1990]. 5p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. (CONF-9007106–30: Institute of nuclear materials management conference, Los Angeles, CA (USA), 15-18 Jul 1990). Order Number DE90013367. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The purpose of the Visual Artificially Intelligent Surveillance (VAIS) System is to test the feasibility of using image processing technology to monitor the movement of personnel and special nuclear materials (SNM) inside production facilities. To fulfill this purpose the VAIS System must to be able detect and track moving objects; detect non-moving objects; classify objects as a type of special nuclear material; and evaluate a set of rules governing the interactions between objects and personnel. The VAIS System will be used as an aid to secure against insider threats by monitoring the area in a camera's field of view and highlighting conditions that may require further evaluation by security personnel. The primary

areas it will be used are sheltered, secured areas where movement of personnel and SNMs is common. The advantage of using image processing is that it can use a video system currently installed in the controlled area and it is generally non-intrusive; it does not require sensors to be attached to the objects or personnel it is tracking. This paper will discuss the goals of the VAIS project, list some major requirements of the system, discuss its design, and give the project status.

40464 (SAND–90-0723C) **The Sandia National Laboratories technology transfer program for physical protection technologies.** Green, M.; Miyoshi, D.; Dry, B. Sandia National Labs., Albuquerque, NM (USA). [1990]. 4p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. (CONF-9007106–13: Institute of nuclear materials management conference, Los Angeles, CA (USA), 15-18 Jul 1990). Order Number DE90013838. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

As the Lead Laboratory for the Department of Energy in the field of physical security, Sandia National Laboratories has had the opportunity to collect extensive amounts of information on the technologies of physical security. Over the past 15 years, the volume of this knowledge has become so extensive that Sandia is now taking steps to make this information as available as possible to the DOE community and, where possible, other government agencies and NRC licensees. Through these technology transfer efforts, there are also programs available that allow cooperative research agreements between Sandia and the private sector as well. Six different technology transfer resources are being developed and used by the Safeguards Engineering Department: (1) tech transfer manuals; (2) SAND documents; (3) safeguards libraries; (4) training courses & conferences; (5) technical assistance & tours; and (6) cooperative research & developments agreements (CRADAs).

40465 (SAND–90-0770C) **Application or removal of safeguards seals by facility operators.** Walford, F.J. (UKAEA Headquarters, London (UK)); Sonnier, C.S.; Mengan, D.L.; Drayer, D.D. Sandia National Labs., Albuquerque, NM (USA). [1990]. 5p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. (CONF-9007106–16: Institute of nuclear materials management conference, Los Angeles, CA (USA), 15-18 Jul 1990). Order Number DE90013841. Available from NTIS, PC A02/MF A01; OSTI; INIS.

In this paper we identify the procedural requirements which would have to be met in order that facility operators could complete some of the seal procedures normally performed by an inspector, thereby reducing the demands for inspector presence at certain crucial times. The most often quoted example is the possibility that, where material is transferred under Agency seal, it may not be necessary for an inspector to be present to reverify the seal on arrival at the receiving facility if a VACOSS type electronic seal is used to record the date and time of seal removal. Although other possible opportunities may exist throughout the fuel cycle for operator use of Agency seals, only situations related to material shipments are considered here. 1 ref., 1 fig.

40466 (SAND–90-0772C) **Authentication system for use at the Fast Critical Assembly (FCA).** Ystesund, K. (Sandia National Labs., Albuquerque, NM (USA)); Perlinski, A.; Young, K.; Garcia, M.L.; Yellin, E.; Janov, J.; Rundquist, D.E.; Mukaiyama, T.; Gaillour, M. Sandia National Labs., Albuquerque, NM (USA). [1990]. 6p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. (CONF-9007106–28: Institute of nuclear materials management conference, Los Angeles, CA (USA), 15-18 Jul 1990). Order Number DE90013354. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Sandia National Laboratories, the International Atomic Energy Agency, and the Japan Atomic Energy Research Institute have designed an authentication system which will allow the IAEA to conduct independent verification of records produced by the Portal Monitor (P/M) and Penetration Monitor (PN/M) systems in the Fast Critical Assembly (FCA) facility in Japan. Authentication Controllers installed at the P/M and at the PN/M will provide passive monitoring capabilities and randomly simulate activation of critical sensors. The Controllers will record data tagged with time and date, and store this information for retrieval by an IAEA inspector using a personal computer. The Authentication Controller clocks are synchronized with the C/S system clock to facilitate comparison of the data produced by the authentication equipment and by the P/M and PN/M. 5 refs., 3 figs.

40467 (SAND–90-0774C) **Installation and operation of the VACOSS-MIVS Interface System at the THTR [Thorium High-Temperature Reactor] facility.** Richter, B. (Forschungszentrum Juelich GmbH (Germany, F.R.)); Stein, G.; Martinez, R.L.; Schneider, S.L.; Heske, M.; Stratmann, H.; Gartner, K.J.; Ammann, P.; Janssens, J.; Terrasi, A. Sandia National Labs., Albuquerque, NM (USA). [1990]. 6p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. (CONF-9007106–21: Institute of nuclear materials management conference, Los Angeles, CA (USA), 15-18 Jul 1990). Order Number DE90013807. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The VACOSS-MIVS-Interface System is a joint development undertaken by Sandia National Laboratories Albuquerque and KFA Forschungszentrum Julich /1,2/. It integrates two existing containment and surveillance technologies into one system with new operational capabilities, with the major objective being to reduce inspection effort while maintaining necessary and sufficient international safeguards assurance. In the absence of a safeguards inspector, the VACOSS-S seal could be handled by a facility operator, while the seal's installation or removal is recorded on video automatically. The recordings include both the scene and the data extracted from the seal. In April 1989, spent fuel was shipped from VAK, Kahl to WAK, Karlsruhe. The VACOSS-MIVS Interface System was successfully field-tested during the cask shipment at VAK and the cask receipt at WAK /3/. Procedural, functional, and design observations were made during that test which were used to improve the system in anticipation of a potential safeguards application. Depending upon the final field test results and the safeguards approach, a first application of the VACOSS-MIVS-Interface System may occur in the Thorium High-Temperature Reactor power plant in the Federal Republic of Germany, where it is intended to ship spent fuel for long-term intermediate storage. The transport and storage of CASTOR casks is designed for sealing the secondary lid with a VACOSS-S electronic seal. In anticipation of safeguards implementation, the THTR facility operator, the safeguards inspectorates of IAEA and Euratom, KFA Julich, and Sandia agreed upon a joint field test of a three-month duration, which started in March 1990. The paper describes this field test, discusses the results and the conclusions. 3 refs., 6 figs.

40468 (SAND–90-0807) **Some implications of the application or removal of agency seals by facility operators.** Walford, F. (UKAEA Atomic Energy Research Establishment, Harwell (UK)); Drayer, D.D.; Sonnier, C.S. Sandia National Labs., Albuquerque, NM (USA). Apr 1990. 14p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC04-76DP00789. Order Number DE90013510. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This report is the outcome of a study of the technical and procedural requirements which would need to be met if the Agency and facility operators were to agree that under certain circumstances the operator could remove or apply on Agency seal in the absence of an inspector. In the FRG and USA Support Programmes respectively an electronic seal (VACOSS) and a CCTV system (MIVS) have been developed. Through a joint project, an interface has been demonstrated which enables the seal data to be superimposed upon the surveillance data. This interface is briefly described in the appendix. A proposed application for this integrated system is to allow facility operators to carry-out some of the seal procedures normally performed by an inspector, thereby reducing the need for inspector presence at certain crucial times.

0560 Legislation and Regulations

Refer also to citation(s) 40400, 40405, 40452, 40672

40469 (CONF-900828–3) **The international radioactive transportation regulations: A model for national regulations.** Pope, R.B.; Rawl, R.R. Oak Ridge National Lab., TN (USA). Jun

1990. 25p. Sponsored by U.S. DOE Radioactive Waste Management. DOE Contract AC05-84OR21400. From Summer national meeting of the American Institute of Chemical Engineers; San Diego, CA (USA); 19-22 Aug 1990. Order Number DE90013829. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

The International Atomic Energy Agency's (IAEA) Regulations for the Safe Transport of Radioactive Material, Safety Series No. 6 (herein after denoted as the "International Regulations") serve as the model for the regulations for individual countries and international modal organizations controlling the packaging and transportation of radioactive materials. The purpose of this paper is to outline the background and history of the International Regulations, the general principles behind the requirements of the International Regulations, the structure and general contents of the latest edition of the International Regulations, and the roles of various international bodies in the development and implementation of the International Regulations and the current status of regulatory and supportive document development at both the international and domestic level. This review will provide a basis for users and potential users to better understand the source and application of the International Regulations. 1 tab.

40470 (IAEA-INFCIRC–379) **Agreement of 2 February 1990 between Saint Lucia and the International Atomic Energy Agency for the application of safeguards in connection with the Treaty on the Non-Proliferation of Nuclear Weapons.** International Atomic Energy Agency, Vienna (Austria). May 1990. 35p. Order Number DE90634379. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The document contains two parts. The first part stipulates the agreement of Saint Lucia to accept safeguards on all source or special fissionable material in all peaceful nuclear activity within its territory, under its jurisdiction or carried out under its control anywhere, for the exclusive purpose of verifying that such material is not diverted to nuclear weapons or other nuclear explosive devices. The second part specifies the procedures to be applied in the implementation of the safeguards provisions of Part 1.

07 ISOTOPE AND RADIATION SOURCE TECHNOLOGY

0701 Physical Isotope Separation

Refer also to citation(s) 41483

40471 (PB–90-868654/XAB) **Laser isotope separation: Non-uranium applications. January 1975-July 1982 (A Bibliography from the INSPEC: Information Services for the Physics and Engineering Communities data base). Report for January 1975-July 1982.** National Technical Information Service, Springfield, VA (USA). May 1990. 223p. Available from NTISPC N01/MF N01.

See also PB–90-868662.

This bibliography contains citations concerning isotope separation by laser irradiation of elements other than uranium. Variations in gas lasers for selective infrared dissociation of molecules, high power laser applications, selectivity considerations, laser isotope separation apparatus and layouts for large facilities, temperature influence on selectivity, and efficiency of processing are among the topics discussed. Applications for boron, tritium, chlorine, and deuterium are included. (This updated bibliography contains 207 citations, none of which are new entries to the previous edition.)

40472 (PB–90-868662/XAB) **Laser isotope separation: Non-uranium applications. August 1982-March 1990 (A Bibliography from the INSPEC: Information Services for the Physics and Engineering Communities data base). Report for August 1982-March 1990.** National Technical Information Service, Springfield, VA (USA). May 1990. 116p. Available from NTISPC N01/MF N01.

Supersedes PB–82-870767. See also PB–90-868654.

This bibliography contains citations concerning isotope separation by laser irradiation of elements other than uranium. Variations in gas lasers for selective infrared dissociation of molecules, high power laser applications, selectivity considerations, laser isotope separation apparatus and layouts for large facilities, temperature influence on selectivity, and efficiency of processing are among the topics discussed. Applications for boron, tritium, chlorine, and deuterium are included. (This updated bibliography contains 203 citations, all of which are new entries to the previous edition.)

0702 Radiation Sources

Refer also to citation(s) 41461

40473 (BARC–1461) **Radiometric scanning of dehydration column at M/s. Reliance Industries Ltd., Patalganga, Rasayani.** Ajmera, R.L. (Bhabha Atomic Research Centre, Bombay (India). Isotope Div.); Pant, H.J.; Eapen, A.C. Bhabha Atomic Research Centre, Bombay (India). 1989. 16p. Order Number DE90633956. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

In chemical processing columns it is often necessary to study the condition of the trays and other fixtures within the column while the column is in operation. It may also be required to study the actual conditions of the process liquids and gases, their quantities and densities in different trays to understand the process conditions. Radioisotope technique has been used in a dehydration column for acetic acid in the PTA plant of M/s. Reliance Industries Ltd., Patalganga, Rasayani to study the condition of the column. The test which has been carried out by Isotope Division involved the use of a sealed radiation source and scintillation detector assembly moved along the length of the cylindrical shaped column so that source and detector are facing each other diametrically at different cross-sections of the column. The intensity of the radiation recorded by the detector is a function of the total weight of intervening material including the shell of the column and any process media and structurals present between the source and detector. It is possible to understand the density variation of the process media as well as any change in the condition or displacement of the fixed structurals from the radiation intensity data obtained. Using the above technique the column with 80 trays and height about 60 meters was evaluated for its condition. It was concluded that the internal conditions were satisfactory for the throughput level existed during the time of investigation. (author). 7 figs.

40474 (CONF-9006235–1) **The Advanced Neutron Source.** Hayter, J.B. Oak Ridge National Lab., TN (USA). [1990]. 16p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. From 114. enrico fermi school of physics; La Specia (Italy); 19-29 Jun 1990. Order Number DE90013381. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

This paper describes the design and operation of the advance neutron source facility. (LSP)

40475 (N–90-18882) **Low-energy gamma ray attenuation characteristics of aviation fuels.** Singh, J.J.; Shen, C.; Sprinkle, D.R. National Aeronautics and Space Administration, Hampton, VA (USA). Langley Research Center. Mar 1990. 40p. (NASA-TP–2974;L–16719;NAS–1.60:2974). Available from NTIS, PC A03/MF A01.

Am241 (59.5 keV) gamma ray attenuation characteristics were investigated in 270 aviation fuel (Jet A and Jet A-1) samples from 76 airports around the world as a part of world wide study to measure the variability of aviation fuel properties as a function of season and geographical origin. All measurements were made at room temperature which varied from 20 to 27 C. Fuel densities (rho) were measured concurrently with their linear attenuation coefficients (mu), thus providing a measure of mass attenuation coefficient (mu/rho) for the test samples. In 43 fuel samples, rho and mu values were measured at more than one room temperature, thus providing mu/rho values for them at several temperatures. The results were found to be independent of the temperature at which mu and rho values were measured. It is noted that whereas the individual mu and rho values vary considerably from airport to airport as well as season to season, the mu/rho values for all samples are constant at 0.1843 + or - 0.0013 cu cm/gm. This constancy of mu/rho value for aviation fuels is significant since a nuclear fuel quantity gauging system based on low energy gamma ray attenuation will be viable throughout the world.

40476 (OEFZS–4536) **Radiation-curable impregnating agents for the consolidation of archaeologic wooden objects.**

Part 4: Summarizing interpretation of the measurements and observations. Schaudy, R.; Knoll, H.; Kalteis, H. Oesterreichisches Forschungszentrum Seibersdorf GmbH (Austria). Inst. fuer Chemie. Apr 1990. 29p. (In German). (CH–411/90). Order Number DE90633963. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

In three preceding reports (OEFZS Report No. 4165, 4195 and 4346) radiation-curable monomers and oligomers have been investigated for their suitability as consolidants of archaeologic and other decayed wood. The application of selected impregnants to standardized wood samples (OEFZS Reports No. 4198 and 4346) showed the complex correlations between wood and polymer component. In this report a summarizing interpretation of the rich data and observations is tried. The experiences from practical conservations contributed to this attempt. 27 refs., 6 tabs., 4 figs. (Authors).

40477 (OEFZS–4537) **Experiences with the location of local gas pipe lines made of plastic.** Frevert, E. Oesterreichisches Forschungszentrum Seibersdorf GmbH (Austria). Inst. fuer Isotopenanwendung. Apr 1990. 19p. (In German). (IA–180/90). Order Number DE90633957. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

In this paper the output, results and experiences are reported which are found by the location of 10 local gas pipe lines with together 87,652 km length. The average daily output were 631 m in 9,3 h. The limiting depth is ca. 150 cm. With aids of the measuring values depth profiles of the pipe lines could be plotted, which shows that places where sewers cross the pipe or are near by and where are vertical levels. Also deformations and cloggings can be found during the location work so that after ending the whole work not only the precise location, length and depth of the pipe line are known but also the whole local gas pipe line is reorganized. 11 figs. (Author).

0704 Economic, Industrial, and Business Aspects

40478 (ORNL/FTR–2720) **[Availability of isotopic materials]: Foreign trip report, September 19, 1987–October 7, 1987.** Adair, H.L. Oak Ridge National Lab., TN (USA). 22 Oct 1987. 28p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC05-84OR21400. Order Number DE90012334. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The traveler visited several installations in Belgium, Germany, and England to meet with users of the enriched stable and radioactive materials provided by the ORNL Isotope Distribution Program (IDP). The purpose of the visits was to determine their future needs for the materials and services provided by the ORNL program and to update our existing or potential future customers on the materials and services presently available from the program. In Belgium and England, extreme interest was expressed among our customers and competitors about the status of the High Flux Isotope Reactor (HFIR) at ORNL. This related mainly to our ability to supply the radioisotopes Ir-192 and Gd-153. A number of concerns were expressed about our ability to provide various stable and radioactive materials. Particular concern was expressed about our present capability to supply enriched Kr-85. The traveler participated in an International Atomic Energy Agency (IAEA) specialists' meeting where the chief topic of discussion was the influence of target and sample properties on nuclear data measurements. At the end of this meeting, plans were formalized for a joint IAEA/International Nuclear Target Development Society (INTDS) meeting on sample fabrication and characterization to be held in Darmstadt, Federal Republic of Germany, in 1988. as President, the traveler conducted the 1987 INTDS Board meeting at the Central Bureau of Nuclear Measurements (CBNM). The major agenda items included the recent changes in the INTDS bylaws, guidelines for future hosts of INTDS meetings, and future directions the Society should take.

08 HYDROGEN

0801 Production

Refer also to citation(s) 40339, 41212

0802 Storage, Transport, and Handling

Refer also to citation(s) 41505

09 BIOMASS FUELS

0908 Production

40479 (EUR–11874) **Production of liquid hydrocarbons from autotrophic microbial biomass by low temperature autocatalytic conversion: Part 3: Harvesting procedures of microalgae in seawater.** Wagener, K. (Technische Hochschule, Aachen (DE)). Commission of the European Communities, Luxembourg (Luxembourg). 1988. 21p. Contract No. EN3B-0019-D(B). Available from NTIS (US Sales Only), PC A03/MF A01.

Large quantities of biomass suitable for conversion into oil can be achieved by large-scale production of fast growing microalgae. The most promising procedure for harvesting is flocculation followed by either settling or floating at the surface due to gas bubbles. Cultures of Tetraselmis tetrathele and Tetraselmis suecica were selected because of their high growth rate. After they reached pH 9.4-9.7, the pH was artifically raised to 10 which brought about flocculation by forming Magnesium Hydroxide as coagulation centres for algal cells. About 90% of the algae in a culture could be harvested in this way. The chemical procedure has been tested under pilot plant conditions involving sedimentation tanks of 1000 - 1300 l. A local raising of the pH in the surface region of these tanks was sufficient to flocculate the algae in the whole volume. This technique is simple, reliable and economically acceptable. To flocculate and harvest a Tetraselmis t. culture with a cell concentration of 0.5g (dry weight) per litre, 40g NaOH/kg algae harvested were needed and only 25g NaOH/kg algae to induce the flocculation of a Tetraselmis s. culture with a cell concentration of 0.9 g/l. These expenditures correspond to 5-10 US cents per kg oil produced by the subsequent conversion process.

0909 Processing

Refer also to citation(s) 40479, 40482, 40957

40480 (PB–90-871641/XAB) **Anaerobic processes in waste treatment: Methane production. July 1978-March 1990 (A Bibliography from the Life Sciences Collection data base). Report for July 1978-March 1990.** National Technical Information Service, Springfield, VA (USA). Jun 1990. 142p. Available from NTISPC N01/MF N01.

This bibliography contains citations concerning research, development, and applications of methane gas production by anaerobic conversion of waste materials, primarily agricultural and animal wastes, but including refuse and sewage wastes. Articles discuss the anaerobic processes involved in waste digestion, the microorganisms responsible for bioconversion of wastes, environmental variables and toxins, and energy production using biogas generators. Both large and small scale systems are considered. (Contains 334 citations fully indexed and including a title list.)

40481 Effects of environmental conditions on xylose fermentation by recombinant Escherichia coli. Ohta, K. (Univ. of Florida, Gainesville (USA)); Alterthum, F.; Ingram, L.O. *Applied and Environmental Microbiology (USA),* 56(2): 463-465 (Feb 1990).

In batch fermentations, optimal conversion of xylose to ethanol by recombinant Escherichia coli was obtained under the following conditions: 30 to 37°C, pH 6.4 to 6.8, 0.1 to 0.2 M potassium phosphate buffer, and xylose concentrations of 8% or less. A yield of 39.2 g of ethanol per liter (4.9% ethanol by volume) was observed with 80 g of xylose per liter, equivalent to 96% of the maximum theoretical yield. Maximal volumetric productivity was 0.7 g of ethanol per liter per h in batch fermentations and 30 g of ethanol per liter per h in concentrated cell suspensions (analogous to cell recycling).

0910 Properties and Composition

Refer also to citation(s) 40957

0980 Waste Management

40482 (EUR–11646) **Economic evaluation of eight methanization plants: Demonstration project.** Corte, P. (Agence Francaise pour la Maitrise de l'Energie, 75 - Paris (FR)). Commission of the European Communities, Luxembourg (Luxembourg). 1988. 139p. (In FR, EN). Contract No. SE/145/81-B. Available from NTIS (US Sales Only), PC A07/MF A01.

The aim of this demonstration project was to construct methanization plants that could be built at a reasonable cost and could be economically viable to assemble. Seven plants were constructed and their performance was monitored. This report gathers together the results obtained in the project and provides an analysis of the operational costs and expenditure and of the biogas production levels achieved. It concludes with an economic analysis of future plants based on the same technology. The following plants were built and are covered in the report: 1. CINEY 1: completely mixed digester, $10m^3$ capacity; 2. CINEY 2: vertical completely mixed digester, $20m^3$ capacity; 3. BAILLONVILLE: plug-flow digester, $20m^3$ capacity; 4. GELUWE: completely mixed digester, $90m^3$ capacity; 5. CORROY-LE-CHATEAU; plug-flow digester, $270m^3$ capacity; 6. OTTEGEM: completely mixed digester, $34m^3$ capacity; 7. HELEGINE: plug-flow digester, $300m^3$ capacity. All can operate semi-continuously, with complete mixing and in mesophilic conditions with residence times of the order of 20 days. The production rate expected was of the order of 0.9 to $1m^3$ of biogas/m^3 of digester capacity per day.

10 SYNTHETIC FUELS

1002 Production

Refer also to citation(s) 40957

40483 (DOE/ID/12797–1) **Development of a High Pressure Heat Exchange System (HIPHES) for reforming of methane: Final report.** Stone and Webster Engineering Corp., Boston, MA (USA). May 1990. 188p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract FC07-88ID12797. Order Number DE90012983. Available from NTIS, PC A09/MF A01 - OSTI; GPO Dep.

Stone & Webster Engineering Corporation (Stone & Webster), under a Cooperative Agreement with the Department of Energy's (DOE) Office of Industrial Programs, is developing a ceramic High Pressure Heat Exchange System (HiPHES) reactor for the convective reforming of natural gas. This report details the results and conclusions from Phase 1 of this planned three phase development program. In Phase 1 Stone & Webster quantified the benefits of ceramic-based reforming, identified potential ceramic materials, developed cost estimates for three 1000 TPD methanol plants using both conventional radiant reforming (two cases) and ceramic-based convective reforming, identified future R&D requirements, and conducted a survey of the potential market for a ceramic HiPHES reformer. Phase 2 will include testing of ceramic materials under reforming reaction conditions as identified in Phase 1, and preparation of a design for a demonstration facility to be built and operated in Phase 3. Stone & Webster was assisted during Phase 1 by the Massachusetts Institute of Technology (MIT), BP America, and Oak Ridge National Laboratory (ORNL). Dr. John Haggerty of MIT conducted a review of currently available ceramic materials and recommended candidates for use as reformer tubes; the results of his review are included in Section 2 of this report. BP America provided consulting in the areas of reformer ano ceramic heat exchanger design and methanol market potential. ORNL conducted a series of tests on the strength and resistance to chemical attack (by a synthesis gas) of eight sample ceramic materials supplied by five ceramic manufacturers. Stone & Webster established the test plan and monitored the test program. 97 refs., 18 figs., 19 tabs.

40484 **Fixed bed and slurry reactor studies of Fischer-Tropsch synthesis on precipitated iron catalyst.** Bukur, D.B. (Texas A and M Univ., College Station (USA)); Patel, S.A.; Lang, X. *Applied Catalysis (Netherlands)*, 61(2): 329-349 (28 May 1990).

A sample of commercial Ruhrchemie catalyst (100 Fe/4.3 Cu/4.1 K/25 SiO_2) for the Fischer-Tropsch synthesis was tested in a fixed bed and in a slurry reactor at process conditions similar to those used in commercial reactors. The apparent reaction rate constant, calculated assuming that the reaction rate has a first order dependence on hydrogen pressure, was nearly the same in both reactors during the first 380 h on stream. The catalyst deactivated slowly with time-on-stream in both reactors, while the hydrocarbon selectivity shifted towards lower molecular weight products. Secondary reactions (1-alkene hydrogenation and isomerization) increased gradually with time-on-stream in the slurry reactor, whereas the opposite trend was observed in the fixed bed reactor. The effects of process conditions on the catalyst activity and product selectivities (hydrocarbon product distribution, total alkene content, 2-alkene selectivity, organic oxygenates) were also investigated. 8 figs., 35 refs., 1 tab.

1003 Properties and Composition

Refer also to citation(s) 41171, 41229

1004 Combustion

Refer also to citation(s) 40956, 40957

13 HYDRO ENERGY

40485 (CRIE-U–89026) **Application of the radar method to the detection of lining condition of the headrace tunnel.** Nakano, T.; Onuma, H.; Kanazu, T.; Ishida, H. Central Research Inst. of Electric Power Industry, Abiko, Chiba (Japan). Oct 1989. 52p. (In Japanese). Order Number DE90507852. Available from NTIS (US Sales Only), PC A04/MF A01.

The thickness of lining concrete is estimated and cavities behind it are detected by means of a radar method at three head-race tunnels for the purpose of putting the method to field test. Details of the method and the measuring equipment for it are given in the author ' s previous paper (1986). Through the tunnel runs a motor-cart loaded with the radar which emitts electromagnetic waves of a frequency 500MHz from an antenna placed close to the surface of lining concrete and receives the waves reflected back from the concrete or cavities behind it. Data aquisition can be preformed at the rate of 500-700m per hour through tunnels having diameters of 2-4m. Recorded data are put to the wave analysis to get desired informations. The results obtained by this method are in fairly good agreement with those by boring. It is noted that the lining concrete which this method can provide good definition of is about 7-50cm in thickness and further improvement in technique is required for making estimate of the size of a cavity behind lining concrete. 5 refs., 14 figs., 9 tabs.

1301 Resources and Availability

40486 (PB–90-870148/XAB) **Pumped storage for hydroelectric power. January 1974-December 1989 (A Bibliography from FLUIDEX data base). Report for January 1974-December 1989.** National Technical Information Service, Springfield, VA (USA). May 1990. 54p. Available from NTISPC N01/MF N01.

Supersedes PB–81-872582.

This bibliography contains citations concerning the design, development, construction, and characteristics of surface and underground pumped storage for hydroelectric power. Pumped storage projects and facilities worldwide are referenced. There is some consideration of research and experimental results of pumped storage studies, as well as modeling. (This updated bibliography contains 124 citations, 68 of which are new entries to the previous edition.)

1306 Environmental Aspects

40487 (DOE/BP–01830-5) **Proceedings of the predator-prey modeling workshop.** Fickeisen, D.H.; Dauble, D.D.; Neitzel, D.A. Pacific Northwest Lab., Richland, WA (USA). Sep 1989. 66p.

Sponsored by U.S. DOE Bonneville Power Administration. DOE Contract AC06-76RL01830. (CONF-8905336–Summ.: Proceedings of the predator-prey modeling workshop, Friday Harbor, WA (USA), 16-19 May 1989). Order Number DE90014149. Available from NTIS, PC A04/MF A01 - OSTI; GPO Dep.

This report summarizes the results of a workshop held to receive expert advice and review existing Columbia River models that include juvenile salmonid predation components and, if warranted, recommend alternate modeling approaches. The workshop was limited to models or modeling approaches that may have practical application to the specific problems of increasing survival of juvenile salmonids in the Columbia and Snake rivers by reducing predation losses. The US Fish and Wildlife Service (FWS) and the Oregon Department of Fish and Wildlife (ODFW) under interagency agreements with the Bonneville Power Administration (BPA) conducted a multi-year study of the impact of predator populations on juvenile salmonids in the John Day Reservoir of the Columbia River. The studies were part of BPA's implementation of the Northwest Power Planning Council's (NPPC) Fish and Wildlife Program, designed to protect and enhance production of salmon as mitigation for losses caused by hydroelectric development. The FWS agreement with BPA includes provisions for refinement or development of models to understand the dynamics of predation on juvenile salmon as a basis for considering active intervention to reduce predation losses. The BPA sponsored the workshop that included a review of existing and proposed modeling approaches, identification of model development needs, and identification of data needs to support modeling efforts. Pacific Northwest Laboratory (PNL) provided workshop design, facilitation, and support services including preparation of this summary. 16 refs., 15 figs., 5 tabs.

40488 (DOE/BP/11631–6) **Smolt monitoring at the head of Lower Granite Reservoir and Lower Granite Dam: Annual report, 1989.** Buettner, E.W. (Idaho Dept. of Fish and Game, Boise, ID (USA)); Nelson, V.L. USDOE Bonneville Power Administration, Portland, OR (USA). Div. of Fish and Wildlife; Idaho Dept. of Fish and Game, Boise, ID (USA). Jun 1990. 59p. Sponsored by U.S. DOE Environment Health & Safety. DOE Contract BI79-83BP11631. Order Number DE90014150. Available from NTIS, PC A04/MF A01 - OSTI; GPO Dep.

This project monitored the daily passage of chinook salmon Oncorhynchus tshawytscha and steelhead trout O. mykiss smolts during the 1989 spring outmigration at a migrant trap on the Snake River and the Clearwater River. Chinook salmon catch at the Snake River trap was much higher in 1989 than in either of the 1987 or 1988 drought years. The 1989 Snake River trap catch was similar to 1986. Effort was the same during the four years. Steelhead trout catch was greater than in any previous year. Chinook salmon and steelhead trout catch at the Clearwater River trap was similar to 1986, even though effort was greatly reduced in 1989 due to high runoff during most of the season. The 1989 Clearwater River trap catch was lower than in the two drought years (1987 and 1988) and was due to the minimal number of days the trap was operated. Fish tagged with Passive Interrogated Transponder (PIT) tags at the Snake River trap were recovered at the three dams (Lower Granite, Little Goose, and McNary) with PIT tag detection systems. Travel time (days) and migration rate (km/d) through Lower Granite Reservoir for PIT-tagged chinook salmon and steelhead trout, marked at the head of the reservoir, was affected by discharge. Statistical analysis showed that as discharge increased from 40 kcfs to 80 kcfs, chinook salmon travel time decreased three-fold and steelhead trout travel time decreased two-fold. 11 refs., 8 figs., 17 tabs.

40489 (DOE/BP/17622–3) **Operation, maintenance and evaluation of the Bonifer and Minthorn Springs juvenile release and adult collection facilities: Annual report, 1988.** Lofy, P.T. (Confederated Tribes of the Umatilla Indian Reservation, Pendleton, OR (USA)). USDOE Bonneville Power Administration, Portland, OR (USA). Div. of Fish and Wildlife; Confederated Tribes of the Umatilla Indian Reservation, Pendleton, OR (USA). Apr 1990. 80p. Sponsored by U.S. DOE Management & Administration. DOE Contract BI79-84BP17622. Order Number DE90014152. Available from NTIS, PC A05/MF A01 - OSTI; GPO Dep.

The Confederated Tribes of the Umatilla Indian Reservation and Oregon Department of Fish and Wildlife are cooperating in a joint effort to increase steelhead and re-establish salmon runs in the Umatilla River Basin. As part of this program, Bonifer and Minthorn Acclimation Facilities are operated for holding adult steelhead and acclimation and release of juvenile salmon and steelhead. Regularly-scheduled maintenance was completed in 1988. A total of 133 adult steelhead were collected at Threemile Dam January through March and held at Minthorn. Thirty-one pairs were spawned. Two marked adult steelhead returned to Bonifer in 1988. However, 250 hatchery steelhead released from Bonifer returned to the Threemile Dam trap. Acclimation and release of 101,000 fall and 106,000 spring chinook salmon were completed at Bonifer. At Minthorn, 101,000 fall chinook and 30,000 summer steelhead were acclimated and released. The progress of outmigration for acclimated releases was monitored at the juvenile salmonid trap located at Westland Diversion. Collection of data to assess the holding and rearing capacities of the two acclimation facilities was initiated. Temperatures and dissolved oxygen were recorded. Test and control groups were coded-wire tagged for one experiment for fall chinook salmon, two experiments for spring chinook salmon and one experiment for summer steelhead. 4 refs., 9 figs., 8 tabs.

40490 (DOE/BP/35769–1) **Umatilla Basin Habitat Improvement Project: Annual report 1989.** Bailey, T.D. Oregon Dept. of Fish and Wildlife, Portland, OR (USA). Jan 1990. 20p. Sponsored by U.S. DOE Bonneville Power Administration. DOE Contract BI79-87BP35769. Order Number DE90014141. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This annual report is in fulfillment of contract obligations with Bonneville Power Administration which is the funding source for the Oregon Department of Fish and Wildlife's Umatilla Basin Habitat Improvement Project. The major activities undertaken during this report period were: procurement of 17 cooperative lease agreements with private landowners, design and layout of 8.6 miles of riparian exclosure fence and 3.0 miles of instream structures, development of five fencing contracts and six instream work contracts. Results include implementation of 10 miles of fencing and 3 miles of instream work. Other activities undertaken during this report period are: data collection from 90 habitat monitoring transects, collection and summarization of temperature data, photopoint establishment, coordination with numerous agencies and tribes and education of all age groups on habitat improvement and protection. 4 refs., 4 figs., 6 tabs.

40491 (DOE/BP/39461–7) **Yakima River spring chinook enhancement study: Annual report, FY 1989.** Fast, D.E. (Yakima Indian Nation, WA (USA). Fisheries Resource Management); Kohn, M.S.; Watson, B.D. USDOE Bonneville Power Administration, Portland, OR (USA). Div. of Fish and Wildlife; Yakima Indian Nation, WA (USA). Fisheries Resource Management. Jul 1990. 94p. Sponsored by U.S. DOE Environment Health & Safety. DOE Contract BI79-83BP39461. Order Number DE90014147. Available from NTIS, PC A06/MF A01 - OSTI; GPO Dep.

Smolt outmigration was monitored at Wapatox on the Naches River and Prosser on the lower Yakima. The survival from egg to smolt was calculated using the 1987 redd counts and the 1989 smolt outmigration at Prosser. Spring chinook were counted at Roza Dam from April 1 to September 29, 1989. The smolt to adult (S_{sa}) survival will be calculated when scale analysis from spawner surveys is complete. Spring chinook adults from ten different experimental release groups were recovered in 1989. A total of 143 coded wire tags were recovered. This project is a multi-year undertaking that will evaluate different management and enhancement strategies. At the conclusion of this study, a series of alternatives will be developed that can be used to determine how best to enhance the runs of spring chinook in the Yakima Basin. 13 refs., 3 figs., 26 tabs.

40492 (DOE/BP/39645–3) **Migratory behavior and adult contribution of summer outmigrating subyearling chinook salmon in John Day Reservoir, 1981–1983: Final report.** Giorgi, A.E.; Miller, D.R.; Sanford, B.P. National Marine Fisheries Service, Seattle, WA (USA). Coastal Zone and Estuarine Studies Div. Apr 1990. 68p. Sponsored by U.S. DOE Management & Administration.

DOE Contract AI79-83BP39645. Order Number DE90014153. Available from NTIS, PC A04/MF A01 - OSTI; GPO Dep.

During summer 1981–1983, the National Marine Fisheries Service investigated the effects of river flow volumes on the travel time of subyearling chinook salmon migrating through John Day Reservoir. Analyses were based on mark recovery data from freeze-branded fish released in the McNary Dam tailrace and recaptured at John Day Dam. In addition to this effort, the distribution of juvenile chinook salmon within the reservoir was observed through purse seine sampling. Coded wire tag data provided a measure of intra- and interannual performance in terms of adult contribution. The travel time data were largely inconclusive. This was due to a poor mark-recovery capability coupled with the difficulty of isolating flow from other closely related variables. A large portion of the juveniles tended to range upstream and did not exhibit consistent displacement downstream. Subyearling chinook salmon migrating through John Day Reservoir early in the summer contributed more adults than those juveniles migrating later in the summer. This pattern was consistent each year. 12 refs., 11 figs., 14 tabs.

40493 (DOE/BP/50301–1) **Biological manipulation of migration rate: The use of advanced photoperiod to accelerate smoltification in yearling chinook salmon: Annual report 1988/1989.** Giorgi, A.E.; Muir, W.D.; Zaugg, W.A.; McCutcheon, S. National Marine Fisheries Service, Seattle, WA (USA). Coastal Zone and Estuarine Studies Div. Feb 1990. 33p. Sponsored by U.S. DOE Bonneville Power Administration. DOE Contract AI79-88BP50301. Order Number DE90013804. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Research was conducted to assess the feasibility of biologically manipulating physiological development and migratory behavior of yearling spring chinook salmon, Oncorhynchus tshawytscha. At Dworshak National Fish Hatchery a treatment group was exposed to a 3-month advanced photoperiod cycle for 14 weeks preceding release. Physiological development and migratory performance of this group was compared to a control group. Changes in physiological indices indicated that exposing fish to an advanced photoperiod treatment increased the rate of smolt development. Photoperiod treatment also altered passage patterns and timing at Lower Granite Dam. 26 refs., 6 figs., 7 tabs.

40494 (DOE/BP/92122–1) **Developing a predation index and evaluating ways to reduce salmonid losses to predation in the Columbia River Basin: Annual progress report, August 1988–September 1989.** Nigro, A.A. Oregon Dept. of Fish and Wildlife, Corvallis, OR (USA). Dec 1989. 357p. Sponsored by U.S. DOE Bonneville Power Administration. DOE Contract BI79-88BP92122. Order Number DE90014145. Available from NTIS, PC A16/MF A01 - OSTI; GPO Dep.

We are reporting progress on the predator-prey study for the period August 28, 1988 to September 1, 1989. The purpose of this research is to evaluate the feasibility of an index for assessment of predation in various reservoirs throughout the Columbia River basin, to describe the relationships among predator-caused mortality of smolts and physical and biological variables; to examine the feasibility of developing bounty, commercial or recreational fisheries on northern squawfish (Ptychocheilus oregonesis); and to develop a plan to evaluate the efficacy of predator control fisheries. Literature searches on predator abundance indexing and factors regulating fish population dynamics have been conducted; selected references have been summarized, and compiled in a key-word bibliography format. The feasibility of various types of predator abundance indices is being assessed; existing data relevant to mark-recapture, catch per unit effort (CPUE), physical and chemical variables, and reservoir morphology have been compiled, reviewed, and summarized. In cases where sufficient data exist, preliminary implementation of predator abundance indices has been demonstrated. Field sampling in John Day Reservoir was conducted during May to August, 1989 – to continue time series data bases on northern squawfish CPUE and growth, and to evaluate the possibility of year class strength determinations of northern squawfish and walleyes using restricted sampling. Development of plans has begun for fishery implementation and evaluation. 184 refs., 33 figs., 35 tabs.

40495 (PB–90-226222/XAB) **Snake river water quality: A discussion of current practices and problems. Technical report.** Moore, Z. Idaho Univ., Moscow, ID (USA). Dept. of Civil Engineering. 1989. 55p. Available from NTIS, PC A04/MF A01.

Water-quality impacts of a single hydroelectric impoundment are relatively simple to predict however, consideration of cumulative impacts to fisheries, wildlife, and water quality resulting from combinations of additional impoundments must also be considered. By constructing a water quality model, the Snake River Risk Assessment team intends to provide the means to fully assess the environmental risks associated with potential individual or multiple hydroelectric developments on the river. Construction of the water quality model remains in the preliminary stages of information gathering and familiarization with water quality concerns in the study area. To facilitate this stage of model development, a data base of pertinent literature and water quality was reviewed and compiled. The following report has been prepared based on the review of the literature contained in the data base.

14 SOLAR ENERGY

1405 Solar Energy Conversion

Refer also to citation(s) 41216

40496 (AD-A–220414/7/XAB) **Interdigitated back-contact silicon solar cell analysis and design recommendations for space use. Technical report.** Marvin, D.C.; Froedge, S.L. Aerospace Corp., El Segundo, CA (USA). Chemistry and Physics Lab. 30 Sep 1989. 31p. (TR–0088(3945-01)-1). Available from NTIS, PC A03/MF A01.

The Interdigitated Back Contact (IBC) solar cell is a relatively new design which has shown unprecedentedly high efficiencies. Silicon Interdigitated Back Contact cells have been fabricated that show greater than 25% efficiency at 100 suns Air Mass 1.5. This is far superior to conventional silicon concentrator cells which are approximately 18% efficient. The purpose of this report is to describe briefly the differences between this technology and conventional cells, demonstrate a near optimum design achieved by two-dimensional numerical simulation, and assess the utility of these cells for space application. The end of life (EOL) performance of this cell design in the radiation environment of space is a critical issue since the high efficiency of the design is predicated on the use of very high quality, long-diffusion length silicon. The radiation-induced degradation of this material is expected to lead to severe efficiency losses. The optimization of cell design to minimize these losses was carried out using a modified version of the 2-dimensional PISCES semiconductor simulator. The final designs presented here show that the performance of IBC cells in space can significantly exceed that of conventional cells.

40497 (AD-A–220500/3/XAB) **Radiation-hard high-efficiency InP space solar-cell development. Quarterly progress report, 12 November 1989-11 February 1990.** Spire Corp., Bedford, MA (USA). Mar 1990. 29p. (SPIRE-QR–10120-03). Available from NTIS, PC A03/MF A01.

The persistent problems which had led to abnormally low voltages and fill factors since the beginning of the contract were solved, allowing production of cells with consistently high efficiencies. The first delivery, of 30 4 sq. cm cells, was made; the efficiencies of these cells (according to Spire measurements) ranged from 15.7% to 18.9%. These efficiencies are essentially equal to those measured in 1987 on Spire epitaxial/implanted cells, which are apparently still a record for the material. These new cells, therefore, would represent the highest efficiency for an all-epitaxial structure as well as the highest efficiency for a large cell. The sudden jump in efficiencies shows that the work done over the past six months on developing advanced thin emitters and refining the processing sequence has been fruitful. Increased collection efficiency due to the emitter improvements described in the last report contributed to the high efficiency of these cells, and simplification of the fabrication process made it possible to produce then on schedule.

40498 (N–90-21274) **Recent results from advanced research on space solar cells at NASA.** Flood, D.J. National Aeronautics and Space Administration, Cleveland, OH (USA). Lewis Research Center. 1990. 9p. (NASA-TM–102485;E–5251;NAS–1.15:102485;CONF-900449–: 12. annual American Society of Mechanical Engineers (ASME) international solar energy conference, Miami, FL (USA), 1-4 Apr 1990). Available from NTIS, PC A02/MF A01.

The NASA program in space photovoltaic research and development encompasses a wide range of emerging options for future space power systems, and includes both cell and array technology development. The long range goals are to develop technology capable of achieving 300 W/kg for planar arrays, and 300 W/sq m for concentrator arrays. InP and GaAs planar and concentrator cell technologies are under investigation for their potential high efficiency and good radiation resistance. The Advanced Photovoltaic Solar Array (APSA) program is a near term effort aimed at demonstrating 130 W/kg beginning of life specific power using thin (62 pm) silicon cells. It is intended to be technology transparent to future high efficiency cells and provides the baseline for development of the 300 W/kg array.

40499 (N–90-21287) **Peeled film GaAs solar cells for space power.** Wilt, D.M.; Deangelo, F.L.; Thomas, R.D.; Bailey, S.G.; Landis, G.A.; Brinker, D.J.; Fatemi, N.S. National Aeronautics and Space Administration, Cleveland, OH (USA). Lewis Research Center. May 1990. 8p. (NASA-TM–103125;E–5453;NAS–1.15:103125). Available from NTIS, PC A02/MF A01.

Gallium arsenide (GaAs) peeled film solar cells were fabricated, by Organo-Metallic Vapor Phase Epitaxy (OMVPE), incorporating an aluminum arsenide (AlAs) parting layer between the device structure and the GaAs substrate. This layer was selectively removed by etching in dilute hydrofloric (HF) acid to release the epitaxial film. Test devices exhibit high series resistance due to insufficient back contact area. A new design is presented which uses a coverglass superstrate for structural support and incorporates a coplanar back contact design. Devices based on this design should have a specific power approaching 700 W/Kg.

40500 (PB–90-868399/XAB) **Biofilms and biofilm reactors. April 1979-March 1990 (A Bibliography from the Life Sciences Collection data base). Report for April 1979-March 1990.** National Technical Information Service, Springfield, VA (USA). May 1990. 74p. Available from NTISPC N01/MF N01.

Supersedes PB–89-867469.

This bibliography contains citations concerning the formation and characterization of biofilms. Biofilms occur in fermentation, wastewater treatment, packed-bed reactors, fluidized-bed reactors, medical prostheses, fouling, biomass reactors, waste supply systems, and other aquatic systems. Topics include microorganism makeup of biofilms, controlling biofilm formation, biological and chemical properties, model studies, kinetic studies, and biofilm identification and detection. (This updated bibliography contains 152 citations, 19 of which are new entries to the previous edition.)

40501 (PB–90-869058/XAB) **Industrial microorganisms: Genetics and microbiology. May 1978-August 1989 (A Bibliography from the Life Sciences Collection data base). Report for May 1978-August 1989.** National Technical Information Service, Springfield, VA (USA). May 1990. 62p. Available from NTISPC N01/MF N01.

This bibliography contains citations concerning the biology, genetics, and use of bacteria, fungi, and yeasts in industrial processes. The production, growth, cultivation, stabilization, and genetic manipulation of these organisms is the central focus of these citations. References to applications in the food, beverage, agricultural, chemical, and pharmaceutical industries are discussed. (Contains 125 citations fully indexed and including a title list.)

40502 (PB–90-869520/XAB) **Genetic engineering: Plasmids. December 1975-April 1990 (A Bibliography from the US Patent data base). Report for December 1975-April 1990.** National Technical Information Service, Springfield, VA (USA). May 1990. 89p. Available from NTISPC N01/MF N01.

Supersedes PB–86-861788.

This bibliography contains citations of selected patents concerning production methods and use of plasmids in recombinant DNA work. Applications of plasmids as cloning vehicles for introducing genetic capabilities into microorganisms are presented. Genetic reagents and techniques for generating plasmids, processes for stabilizing plasmids and the microorganisms containing them, and uses in the fermentive production of amino acids are also discussed. (This updated bibliography contains 188 citations, 123 of which are new entries to the previous edition.)

40503 (PB–90-871484/XAB) **Cellulose and lignin: Biodegradation. December 1985-May 1990 (A Bibliography from the Biobusiness data base). Report for December 1985-May 1990.** National Technical Information Service, Springfield, VA (USA). Jun 1990. 76p. Available from NTISPC N01/MF N01.

Supersedes PB–89-863385.

This bibliography contains citations concerning the biodegradation of materials containing cellulose and lignin components. Natural wood decay and sludge digestion are considered. Detailed chemical and physical mechanisms of degradation and research on microorganisms involved are discussed for a variety of cellulose and lignin containing materials including straw, municipal wastes, living trees, paper, lumber, and grasses. Genetic engineering studies regarding the isolation, preparation, and characterization of suitable microorganisms for cellulose and lignin degradation are included. (This updated bibliography contains 135 citations, 48 of which are new entries to the previous edition.)

40504 (SAND–90-1767C) **Uv-induced degradation of the Si-SiO_2 interface: Applications to the point contact solar cell.** Schubert, W.K.; McBrayer, J.D.; Buck, M.E.; Tingley, J.W. Sandia National Labs., Albuquerque, NM (USA). [1990]. 5p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC04-76DP00789. (CONF-9008124–1: 1990 DOE/Sandia crystalline photovoltaic technology project review meeting, Albuquerque, NM (USA), 7-9 Aug 1990). Order Number DE90013843. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Prior research has concentrated on damage at the Si–SiO_2 interface caused by photoinjection of electrons into the oxide by near UV light. The damage processes involved may be similar to those responsible for degradation in the Stanford type, point contact solar cell (PCSC). 7 refs., 6 figs.

40505 (SAND–90-7029) **High-temperature deformation of silicon.** Ast, D.G. (Cornell Univ., Ithaca, NY (USA). Dept. of Materials Science and Engineering). Sandia National Labs., Albuquerque, NM (USA); Cornell Univ., Ithaca, NY (USA). Dept. of Materials Science and Engineering. Jun 1990. 38p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC04-76DP00789. Order Number DE90013628. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

We used four-point bending to investigate the high-temperature stress-strain properties of silicon containing planar defects. We performed load increment tests on samples of Solarex silicon from ingots grown by the company's standard method and from those grown with two separate modifications to its standard growth method. All three materials were deformed at 1100°C, with the applied stress increasing incrementally over the period of the test. They were also compared with Wacker Silso samples. Electrical activity of the defects was investigated using electron-beam induced current measurements at both low and high accelerating voltages. We also began basic investigations on the reversibility of plastic deformation at high temperatures by singly bending, and by bending and reflattening single-crystal Czochralski and Float Zone silicon samples. 33 refs., 14 figs., 4 tabs.

40506 (SERI/TP–211-3643, pp. 10-11) **Amorphous silicon research project.** Luft, W.; Stafford, B.; Wallace, W. Solar Energy Research Inst., Golden, CO (USA). Mar 1990. In *Photovoltaic Program Branch annual report, FY 1989.* Order Number DE90000318. Available from NTIS, PC A13/MF A01.

The objectives of this research in amorphous silicon are to improve and understand the optoelectronic properties of amorphous-silicon-based alloy materials and to improve the conversion efficiency and stability of single-junction and multijunction solar cells and submodules. The research is directed toward achieving

the FY 1990 goals, which are 10% efficiency for single-junction and 13% for multijunction submodules of 900-cm^2 area. The technical plan of the Amorphous Silicon Research Project (ASRP) is divided into two principal activities: (1) multidisciplinary research and (2) fundamental research. The multidisciplinary research activities comprise the government industry cost-shared programs that have broad-based research teams located at the facilities of the individual companies. These teams perform directed research that covers aspects from starting materials to demonstration of proof-of-concept cells and submodules. Fundamental research, involves basic, higher-risk, and supporting research at universities and research laboratories that aids industry by advancing the technology base. Cost-shared multidisciplinary programs address issues concerning single-junction and multijunction devices. Research is to advance the conversion efficiency and the stability of both small-area cells and large (900-cm^2 and up) submodules fabricated by plasma enhanced CVD. The stability encompasses both intrinsic aspects, such as the light-induced effect, and extrinsic aspects, such as diffusion or corrosion as a result of the environment. The efficiency improvement involves improving light trapping, achieving higher conductivity of interconnectors, and minimizing area losses due to interconnections. After the first government industry program conducted from FY 1984 through FY 1987, the best single-junction a-Si cells had efficiencies as high as 11.7% and single-junction a-Si submodules had efficiencies up to 7.9%.

40507 (SERI/TP–211-3643, pp. 12-17) **Research on amorphous silicon-based thin film photovoltaic devices.** Mitchell, K.W. (ARCO Solar, Inc., Camarillo, CA (USA)); Eberspacher, C.; Tanner, D.; Willett, D. Solar Energy Research Inst., Golden, CO (USA). Mar 1990. In *Photovoltaic Program Branch annual report, FY 1989.* Order Number DE90000318. Available from NTIS, PC A13/MF A01.

The primary goal of this contract, which began July 1987, is to develop stable, 13% efficient multijunction thin film modules using thin film silicon:hydrogen alloy (TFS) for the high band gap circuit and a copper indium diselenide (CIS) device for the low band gap circuit. TFS and CIS were selected because they are the leading thin film materials at present and because they have a near-ideal band gap match of 1.7 eV and 1.0 eV, respectively. Modeling calculations indicate practical, achievable efficiencies in the range of 20% for this combination. The issues are divided into four major tasks: (1) the materials and device physics of TFS and CIS junctions; (2) process development for large area coating to achieve the requisite electronic quality thin films; (3) the optimization of device configuration and optical coupling for tandem modules; and (4) process development for module patterning and encapsulation. These are described in detail. 10 refs., 1 fig., 5 tabs.

40508 (SERI/TP–211-3643, pp. 18-22) **Research onstable, high efficiency, large area, amorphous silicon based submodules.** Delahoy, A.E. (Chronar Corp., Princeton, NJ (USA)); Kampas, F.J.; Ellis, F.B. Jr.; Schade, H.; Tonon, T.; Weakliem, H.A. Solar Energy Research Inst., Golden, CO (USA). Mar 1990. In *Photovoltaic Program Branch annual report, FY 1989.* Order Number DE90000318. Available from NTIS, PC A13/MF A01.

The primary objective of this subcontract is to develop same bandgap amorphous silicon p-i-n/p-i-n tandem junction photovoltaic submodules ({ <=} 900cm^2) having an aperture area efficiency of at least 9%. A further objective is to demonstrate 8% tandem submodules that degrade by no more than 5% under standard light soaking conditions. Chronar's approach to the attainment of these objectives is based on the following distinctive technologies: (a) in-house deposition of SiO_2/SnO, by APCVD onto soda lime glass to provide the substrate for subsequent a-Si:H deposition, (b) single chamber r.f. glow discharge deposition of the a-Si:Hp-i-n layers with the discharge confined to an inner box carrier that holds the substrates, (c) laser scribing of the three films (SnO, a-Si:H, Al) with real-time scribe tracking to minimize area losses. We further consider it important to examine the consequences of using an alternative transparent conductor, and have selected ZnO for this purpose. Continued optimization of the a-Si:H component of tandem cells resulted in the achievement of 8.7% conversion efficiency for a 1 cm^2 cell. The J-V curve for this cell is shown in Fig. 1. The cell featured carbon-graded P-layers, a 100 A TiOX interstack recombination layer to improve the fill factor, and a modified transitional i-layer in the second stack. It has been clearly demonstrated that tandem junction cells can provide a higher stabilized power output than single junction cells. 7 refs., 4 figs.

40509 (SERI/TP–211-3643, pp. 23-25) **Research on high-efficiency, multiple-gap, multi-junction amorphous silicon-based alloy thin film solar cells.** Guha, S.; Banerjee, A.; Bernotaitis, C.; Burdick, J.; Chen, E.; Glatfelter, T.; Hammond, G.; Hopson, M.; Laarman, T.; Lycette, M. Solar Energy Research Inst., Golden, CO (USA). Mar 1990. In *Photovoltaic Program Branch annual report, FY 1989.* Order Number DE90000318. Available from NTIS, PC A13/MF A01.

The research program is directed toward advancing the understanding of amorphous silicon-based alloys and their use in small area, multijunction, multi-band gap solar cells. The principal objectives are (1) to develop a broad scientific base for the chemical, structural, optical, and electronic properties of amorphous silicon-based alloys; (2) to determine the optimum properties of alloy materials as they relate to high-efficiency cells; (3) to determine the optimum device configuration for multijunction cells; and (4) to demonstrate by February 1990 the proof-of-concept, multijunction amorphous silicon alloy-based solar cells having an efficiency of 16% under standard AM1.5 global insolation conditions and having an area of at least 1 cm^2. ECD has been using rf glow-discharge decomposition approach to deposit amorphous silicon alloy materials (a-Si:H:F, a-Si:Ge:H:F). In order to obtain high efficiency with good stability, a multijunction triple cell configuration has been used in which different band gap materials are used to capture the wide spectrum of solar photons. The different band gap materials are being optimized for incorporation in the cells. Novel cell designs are also being investigated to obtain higher efficiency with good stability. The tasks of the subcontract relate to materials, singlejunction cell and multijunction cell research. In order to obtain high efficiency multijunction a-Si alloy solar cells, the following requirements have to be fulfilled: 1. Optimized back reflector to facilitate light trapping, 2. Suitable anti reflection coating, 3. High quality doped layer, 4. High quality narrow band gap material, 5. Optimized device design and 6. Optimum matching of cells. All these areas have been investigated during the current year. Some of the highlights are detailed. 7 refs., 1 fig.

40510 (SERI/TP–211-3643, pp. 26-28) **Research on the material properties of device quality amorphous silicon deposited at high deposition rates using higher order silanes.** Chatham, H. (Glasstech Solar, Inc., Wheat Ridge, CO (USA)); Bhat, P.K.; Shen, D.; Matovich, C.E.; Benson, A. Solar Energy Research Inst., Golden, CO (USA). Mar 1990. In *Photovoltaic Program Branch annual report, FY 1989.* Order Number DE90000318. Available from NTIS, PC A13/MF A01.

The major objectives of this research during FY 1989 were to obtain improvements in the material properties of intrinsic amorphous silicon (a-Si:H) films deposited from disilane at high deposition rates (up to 2 nm/s) and to demonstrate an a-Si:H p-i-n device with the intrinsic layer deposited from disilane at a rate of at least 2 nm/s having an AM1.5 efficiency of at least 9% over an area of 1 cm^2. The objectives of the current phase of research (commencing in the last few months of FY 1989) are to (1) demonstrate a p-i-n device with the intrinsic layer deposited at a rate of at least 2 nm/s having an efficiency of at least 10% (June 1990) and (2) to demonstrate a single or tandem junction p-i-n device with the intrinsic layer(s) deposited at 2 nm/s having an AM1.5 efficiency of at least 10% after 200 h of equivalent AM1.5 illumination (June 1991). The general approach undertaken during FY 1989 was to focus on improving the properties of intrinsic materials deposited at high deposition rates and to optimize the performance of devices fabricated with these intrinsic layers. High quality intrinsic materials were deposited at high rates using 110 MHz disilane discharges. Significant results are discussed. 1 refs., 1 figs., 1 tabs.

40511 (SERI/TP–211-3643, pp. 29-31) **Characterization and comparison of optically transparent and conducting films.** Gordon, R.G. (Harvard Univ., Cambridge, MA (USA)); Hu, J.; Giunta, C.; Musher, J. Solar Energy Research Inst., Golden, CO (USA).

Mar 1990. In *Photovoltaic Program Branch annual report, FY 1989*. Order Number DE90000318. Available from NTIS, PC A13/MF A01.

Transparent conducting materials are essential components of thin-film solar cells, in which they serve as front-surface electrodes. In tandem cells, back surface electrodes also need to be transparent. Finally, some designs for highly reflective back contacts also call for a transparent conducting layer. The compositions of these transparent conducting layers are usually based on oxides of tin, indium and/or zinc, and are hence referred to as transparent conducting oxides (TCO). In addition to having low electrical resistance and low optical absorption, the structure of a TCO must minimize reflection losses. The TCO must also resist degradation during cell fabrication and use. Finally, the method for making the TCO must be inexpensive and safe. The general objectives are to improve the performance of TCO materials and the methods for their production. We aim to reduce their electrical resistance, optical absorption and reflection losses, and to avoid degradation of the materials. For the production method, the prime consideration is to deposit the TCO layers at a high rate with relatively simple apparatus. We have concentrated our attention primarily on fluorine-doped zinc oxide, since zinc metal is much less expensive than tin or indium. Also, zinc is much more abundant in the earth's crust, than is tin or indium, so that even large-scale use of solar cells would not lead to any shortage of zinc. Another advantage of zinc oxide is its greater stability toward hydrogen plasmas used to deposit amorphous silicon solar cells. As a preparation method, we chose chemical vapor deposition (CVD), since for many materials, the highest deposition rates have been achieved using CVD. When operated at atmospheric pressure, CVD requires only simple equipment which is commercially available and capable of large-area coating. 2 figs.

40512 (SERI/TP–211-3643, pp. 32-34) **Structural and electronic studies of a-SiGe:H alloys.** Paul, W. (Harvard Univ., Cambridge, MA (USA)). Solar Energy Research Inst., Golden, CO (USA). Mar 1990. In *Photovoltaic Program Branch annual report, FY 1989*. Order Number DE90000318. Available from NTIS, PC A13/MF A01.

The principal objectives of this research have been (1) to carry out a detailed study of the structural, electrical and optical properties of a-Ge:H, the end-component of the a-$Si_{1-x}Ge_x$:H alloy series, in order to determine the values of deposition parameters optimizing the properties relevant to photovoltaic devices, (2) to deposit films of a-Si:H and a-Ge:H by photo-chemical-vapor deposition, in order to augment the study of films produced by glow discharge, and to see if insight into deposition processes is available from study of this method, (3) to collaborate with Professor Richard Norberg of Washington University to prepare films of a-Si and a-Ge containing deuterium, so that the Norberg laboratory can study deuteron magnetic resonances (DMR), and provide information on the microstructure of films on a 100 Å scale, (4) to collaborate with Dr. M. L. Theye of the Laboratoire d'Optique, University of Paris, to explore low photon energy absorption spectra determined either by photothermal deflection spectroscopy (PDS) or steady-state photoconductivity (PC), (5) to collaborate with Professor I. Chambouleyron of the University of Campinas on the properties of a-Ge:H prepared by reactive sputtering (Campinas) and plasma-enhanced CVD (Harvard), and (6) to collaborate with Professor J. Chen of Boston College on electron spin resonance spectra of hydrogenated amorphous semiconductors. Films were prepared by r.f. glow discharge, reactive sputtering and photo CVD. Measurements included conductivity versus temperature, optical absorption in the sub-band-gap region of the spectrum, optical vibrational absorption in the infrared region, photoconductivity spectra, photoluminescence spectra, Raman spectra, gas evolution, transmission and scanning electron microscopy, Rutherford backscattering, differential scanning calorimetry and deuteron and electron magnetic resonance. 9 refs.

40513 (SERI/TP–211-3643, pp. 35-40) **Photochemical vapor deposition of amorphous silicon alloy materials and devices.** Baron, B.N. (Univ. of Delaware, Newark (USA)); Fortmann, C.M.; Hegedus, S.S.; Buchanan, W.A.; Zhou, T.X. Solar Energy Research Inst., Golden, CO (USA). Mar 1990. In *Photovoltaic Program Branch annual report, FY 1989*. Order Number DE90000318. Available from NTIS, PC A13/MF A01.

Research on photochemical vapor deposition of amorphous silicon materials addresses the limits of material preparation and to demonstrate proof-of-concept solar cells. The objectives are to develop low band gap a-SiGe:H cells for use in high efficiency, stable multijunction thin film solar cells and determine and understand the origin of Staebler-Wronski effect degradation in a-Si:H cells. IEC is focusing on the transport properties of low band gap a-SiGe:H alloys as they relate to solar cell performance. Studies of the relationships between i layer electronic transport and deposition conditions are integrated with detailed investigations of device behavior. The a-SiGe:H materials are prepared in a photo-CVD deposition system providing state-of-the-art a-Si:H materials and devices. Alloy films and devices are being prepared with a range of H and Ge contents. Film analyses include: optical absorption, conductivity, IR analysis, and Raman scattering. The performance of p-i-n solar cells with an i-layer bandgap of approximately 1.3 eV are studied as a function of H and Ge content and i-layer thickness. The effects of i-layer compositional grading on alloy cell performance are studied by fabricating and characterizing the I-V behavior and spectral response of p-i-n devices with graded alloy i-layers. A mathematical model for transport in graded i-layer devices is being developed. The origins of the defects involved in Staebler-Wronski (S-W) effect are being investigated using a-Si:H p-i-n cells as the test device. Cells are degraded at high temperatures (150-175°C) by current injection and the steady state density of defects is measured using the short wavelength quantum efficiency (SWQE) method. The effect of H content on S-W defect formation is studied by using photo-CVD to fabricate cells with i-layers having a range of H contents. Significant results are discussed. 5 refs., 3 figs., 1 tab.

40514 (SERI/TP–211-3643, pp. 41-46) **Amorphous silicon deposition research with in situ diagnostics.** Shing, Y.H. (California Institute of Technology, Pasadena (USA)); Pool, F.S.; Allevato, C.E.; Yang, C.L. Solar Energy Research Inst., Golden, CO (USA). Mar 1990. In *Photovoltaic Program Branch annual report, FY 1989*. Order Number DE90000318. Available from NTIS, PC A13/MF A01.

The objectives of this task are: (1) to develop device-quality hydrogenated amorphous silicon carbon alloy thin films (a-SiC:H) using electron cyclotron resonance deposition technology; and (2) to evaluate electron cyclotron resonance and glow discharge deposition processes through in situ plasma diagnostics and device performance. JPL has established state-of-the-art amorphous silicon deposition capabilities using radio frequency (13.56 MHz) glow discharge and microwave (2.45 GHz) electron cyclotron resonance (ECR) techniques. The JPL glow discharge and ECR deposition systems are capable of performing in situ plasma diagnostic experiments. An RF induction heated sample stage has been designed and installed in the ECR deposition system. The high temperature (up to 1000°C) heating capability is employed to investigate ECR deposition processes in a wide temperature range for developing an understanding on the film stability and growth mechanisms. ECR microwave plasma CVD has been developed at low pressures (10^{-4} - 10^{-2} Torr), at ambient and high substrate temperature (up to 750°C), to achieve large-area (>4 inch diameter) depositions of amorphous silicon (a-Si:H), amorphous carbon (a-C:H) are a-SiC:H alloy films. The ion energy effect in modifying the electronic and structural properties of ECR-deposited films is studied by applying an RF bias to the substrate stage. In situ optical emission spectroscopy (OES) plasma diagnostics are employed to determine the characteristics difference between ECR and RF glow discharge deposition processes. The optical, electrical and morphological properties of thin film samples are characterized by infrared, visible transmission, Raman spectroscopy, light and dark conductivity measurements. 4 refs., 6 figs.

40515 (SERI/TP–211-3643, pp. 50-55) **Research on stable, high-efficiency, large area, amorphous silicon based submodules.** Catalano, A.; Arya, R.R.; Bennett, M.S.; Fieselmann, B.; Goldstein, B.; Morris, J.; Newton, J.; Oswald, R.S.; Podlesny, R.; Wiedeman, S. Solar Energy Research Inst., Golden, CO (USA). Mar 1990. In *Photovoltaic Program Branch annual report, FY 1989*. Order Number DE90000318. Available from NTIS, PC A13/MF A01.

The objective is to demonstrate a conversion efficiency of at least 14% for a large area ({ >=} 900 cm^2) multijunction submodule. Trimethylboron (TMB) has proved to be a superior dopant for a-SiC:H p-layers. A 0.1 eV increase in optical bandgap for these films compares to control films doped with diborane. Small area (< 1 cm^2) devices have exhibited open circuit voltages as high as 0.943 Volts and unoptimized devices have yielded AM1.5 conversion efficiencies as high as 11.4%. Table 1 compares device performance to a diborane doped control, and the properties of the doped films. Deposition of a-SiGe:H alloy films from the hydrogen diluted feedstock yields diffusion lengths approximately 200A larger over a wide range of bandgap (1.7 eV - 1.38 eV). Hydrogen diluted silicon-germanium alloys appear to be more stable than their undiluted counterparts. The Urbach Energy determined from Photothermal Deflection Spectroscopy is low and increases little with decreasing bandgap. The midgap density of states does not appear to increase with Ge content but a large thickness dependence in Urbach Energy midgap state density and diffusion length has been found suggesting that these measurements are strongly affected by surface recombination. Boron doping has a marked effect on the photoconductivity and diffusion length, L of a-Si:H and the a-SiGe:H alloys. An increase in L occurs for low levels of B-doping up to about 0.4 and 0.2 ppm for a-Si:H and 1.6 eV a-SiGe:H. A concurrent minima in photoconductivity is also found. This indicates a transition from hole to electron minority carrier transport. Nonsemiconductor materials research has been directed at the scale up of reactively sputtered ITO for submodules over 900 cm^2. Computer-assisted modeling includes - cell design to itemize losses in multi-junction cells and module design to determine the origin and magnitude of resistive losses. 4 figs., 3 tabs.

40516 (SERI/TP–211-3643, pp. 56-59) **Studies on the relative effects of charged and neutral defects in hydrogenated amorphous silicon.** Silver, M. (Univ. of North Carolina, Chapel Hill (USA)); Han, D.; Wang, K.; Zvanut, M.E.; Kemp, M. Solar Energy Research Inst., Golden, CO (USA). Mar 1990. In *Photovoltaic Program Branch annual report, FY 1989.* Order Number DE90000318. Available from NTIS, PC A13/MF A01.

The objectives were to evaluate the relative effects of neutral and charged defects by theoretical and experimental means. In this endeavor, we collaborated with many other groups. Our most extensive work was with Howard Branz of S.E.R.I. We also worked closely with Professor Bassler of the University of Marburg FRG and were kindly supplied with samples from Alan Delahoy of Chronar. Perhaps the most important theoretical results were the prediction that copious amounts of charged defects ($T\pm_3$) can coexist with neutral dangling bonds and that these charged defects can be responsible for the exponential band tails. We further found a reasonable mechanism for metastability based on the photo-neutralization of the charged defects by excess carriers. Experimentally, from a study of forward bias currents on p/i/n devices we believe that we have measured the temperature for a transition from band motion to hopping. 3 figs.

40517 (SERI/TP–211-3643, pp. 60-63) **Investigations of the origins of light-induced changes in hydrogenated amorphous silicon.** Cohen, J.D. (Univ. of Oregon, Eugene (USA)); Essick, J.M.; Leen, T.; Unold, T. Solar Energy Research Inst., Golden, CO (USA). Mar 1990. In *Photovoltaic Program Branch annual report, FY 1989.* Order Number DE90000318. Available from NTIS, PC A13/MF A01.

The photoinduced increase in the midgap region of the density of states in undoped a-Si:H is generally attributed to a creation of dangling bond defects induced when the recombination of photoinduced carriers breaks weak Si-Si bonds. In the case of doped films, however, the situation may be more complicated since we can also have activation or deactivation of dopant atoms. During the previous year (FY1988) we had investigated metastable states produced by prolonged light exposure and partial annealing. During the past year we have expanded our studies to look at metastable changes due to quench cooling and bias annealing in such samples. In all such studies we document the changes that occur both in the occupied bandtail (NBT) states and also dangling bond defects (ND) Correlations in the changes in ND and NBT can be used to distinguish among various defect reactions that have been proposed to explain the metastable changes in n-type doped films. To determine the conduction bandtail occupation of states we used drive-level profiling measurements as described previously. 1,2 Specifically, for a 10 kHz measurement frequency and a 250K temperature this method gives explicitly the value of the integral of the occupied states from the bulk Fermi level down to an energy of roughly 0.4 eV below E_C. The change in the number of deep gap states, ND' as studied by the voltage pulse transient photocapacitance technique.3,4 Such spectra appear qualitatively similar to and are interpreted in our study like sub-band-gap optical absorption spectra. 9 refs., 3 figs.

40518 (SERI/TP–211-3643, pp. 64-69) **Structure of amorphous silicon alloy films.** Norberg, R.E. (Washington Univ., St. Louis, MO (USA)); Fedders, P.A. Solar Energy Research Inst., Golden, CO (USA). Mar 1990. In *Photovoltaic Program Branch annual report, FY 1989.* Order Number DE90000318. Available from NTIS, PC A13/MF A01.

The principal objective has been to improve our understanding, at the microscopic level, of the structure of amorphous silicon-germanium alloy films by means of joint theoretical and experimental approaches to the correlation of results of nuclear magnetic resonance, electron spin resonance, transmission electron microscopy, and other measurements. A major focus is the examination of significant rearrangements of hydrogen that take place under various deposition and postdeposition conditions. Deuteron magnetic resonance (DMR) was used to examine the structure of plasma-deposited film samples of a-Si:D,H; a-Si:D; a-Ge:D,H; and a-SiGe:D,F prepared at Harvard by W. Paul and W. Turner. The results have been compared with DMR data obtained in samples provided by other laboratories. DMR resolves and quantifies spectral components for tightly bound deuterium (TBD), weakly bound deuterium (WBD), rotating silyl groups, molecular D_2 and HD in microvoids, and molecular D_2 and HD trapped in { <=} 4 A nanovoids. Calculations concerning strain effects on defect states are compared with electron spin resonance results. The measurements are being extended to the examination of the effects of post-deposition annealing and gas evolution on microstructure and on such microdynamics as the intervoid hopping of molecular HD. Proton and deuteron spin-decoupling methods are employed to enhance the spectral resolution. Composite-pulse methods and multiple-pulse echo sequences are used to improve the spectral coverage and to examine the time decay of quadrupolar order. The purpose of the measurements is to correlate DMR-deduced microstructural morphology and microstructural dynamics with electrical properties. The dynamics of molecular D_2 and HD are correlated with preparation methods and with the photoelectronic properties of the alloy material. 6 refs., 4 figs., 1 tab.

40519 (SERI/TP–211-3643, pp. 70-75) **Research on the structural and electronic properties of amorphous silicon alloys.** Boyce, J.B.; Jackson, W.B.; Johnson, N.M.; Street, R.A.; Thompson, R.; Tsai, C.C.; Winer, K. Solar Energy Research Inst., Golden, CO (USA). Mar 1990. In *Photovoltaic Program Branch annual report, FY 1989.* Order Number DE90000318. Available from NTIS, PC A13/MF A01.

The primary research goals of this project are to improve the performance of.aSi:H-based solar cells through the understanding of metastability, doping and growth. The thermodynamics of defects and the chemical equilibrium models of growth are discussed. One of the main materials problems of amorphous silicon technology is the phenomenon of metastability, in which the electronic properties depend on the thermal and electrical history of the sample. A key observation is that the defects are in thermal equilibrium with the disordered structure. We have made experimental and theoretical studies of the thermal equilibrium defect density in undoped a-Si:H. The defect density measured by electron spin resonance, increases with temperature with an activation energy of 0.15-0.2 eV as is shown in Fig. 1. 12 refs., 5 figs.

40520 (SERI/TP–211-3643, pp. 76-77) **Polycrystalline thin films.** Zweibel, K.; Ullal, H.; Mitchell, R. Solar Energy Research Inst., Golden, CO (USA). Mar 1990. In *Photovoltaic Program Branch annual report, FY 1989.* Order Number DE90000318. Available from NTIS, PC A13/MF A01.

The objective is to develop thin-film, flat-plate modules that meet DOE's long-term goals of reasonable efficiencies (15%-20%), very low cost (near $50/m^2), and long-term reliability (30 years). The approach relies on developing pv devices based on highly light-absorbing compound semiconductors such as $CuInSe_2$, CdTe, and their alloys. These semiconductors are fabricated as thin films (1-3 μ thick) with minimal material and processing costs. Very high efficiencies have been achieved by these materials. $CuInSe_2$ cells made by ARCO Solar and by Boeing were measured at SERI at 13.1% and 12.9% efficiency. ARCO Solar reports achievement of a 14.1% efficiency. Others surpassing 10% efficiency in $CuInSe_2$, are SERI, International Solar Electric Technology, and Institute of Energy Conversion. Larger area $CuInSe_2$ devices have also been fabricated with very high efficiencies. ARCO Solar has made a 938-cm^2 (aperture area) $CuInSe_2$ module with 11.1% efficiency (10.4 W), and an 8.5% (4-ft^2) module. $CuInSe_2$ shows good stability under controlled conditions (9000 of illumination). A full year outdoor testing on two ARCO Solar $CuInSe_2$ panels shows very little change in their efficiencies (under 4%). Three U.S. laboratories report CdTe cell efficiencies between 10.5% and 12.5%. Photon Energy has fabricated near-square-foot CdTe submodules measured outdoors at SERI at 7.3% efficiency (aperture area). They also have the world record in CdTe cell efficiency (12.3%). The improved efficiencies and larger areas of $CuInSe_2$ and CdTe devices, and their apparent stability, are the major recent advances in these technologies, but polycrystalline cells require continued development to achieve 15%-20% conversion efficiencies. Two strategies are being used: development of single-junction cells and an innovative effort on two-junction cascade cells.

40521 (SERI/TP–211-3643, pp. 78-81) **Polycrystalline thin-film cadmium telluride solar cells.** Meyers, P. (Ametek Applied Materials Lab., Harleysville, PA (USA)); Liu, R. Solar Energy Research Inst., Golden, CO (USA). Mar 1990. In *Photovoltaic Program Branch annual report, FY 1989.* Order Number DE90000318. Available from NTIS, PC A13/MF A01.

The overall objective of this subcontract is to develop thin-film solar cells that are improvements on the present state of the art. The work is centered around the polycrystalline n-i-p configuration utilizing CdS/CdTe/ZnTe. Already devices of this structure have been produced with confirmed efficiency of 11.2%. Stability testing of mini-modules indicates that these devices are stable under load and illumination for at least 4200 hours. 4 refs., 5 figs.

40522 (SERI/TP–211-3643, pp. 81-84) **High efficiency $CuInSe_2$ and $CuInGaSe_2$ based cells and materials research.** Devaney, W.E. (Boeing Aerospace and Electronics Seattle, WA (USA)); Chen, W.S.; Stewart, J.M.; Mickelsen, R.A. Solar Energy Research Inst., Golden, CO (USA). Mar 1990. In *Photovoltaic Program Branch annual report, FY 1989.* Order Number DE90000318. Available from NTIS, PC A13/MF A01.

The overall objective of this research program was the demonstration of improved performance for photovoltaic devices based on the ternary compound $CuInSe_2$ and its quaternary analog $CuInGaSe_2$. The program was for two years and has just been completed. The detailed objectives and a more complete description of the first year results are contained in the 1988 Photovoltaic Program Branch Annual Report. During the first year of the contract a ZnO/CdZnS/$CuInGaSe_2$ cell of area 1 cm^2 was fabricated with a total area efficiency of 12.5% and an active area efficiency of 12.9% (AMI.5 global spectrum, 100 mW/cm^2 equivalent intensity) as measured at SERI. The $CuInGaSe_2$ layer was vapor deposited on a molybdenum coated alumina substrate by vacuum deposition from elemental sources. The CdZnS was grown on the $CuInGaSe_2$ by chemical deposition from solution and the ZnO was deposited by reactive sputtering. During the past year an extensive optical analysis of this device was done. The structure which resulted from this analysis is summarized in Figure 1. A more extensive description of the device fabrication process and structure is given in Reference 1. The major result of this first year effort was the demonstration of higher efficiencies with the ZnO/CdZnS/$CuInGaSe_2$ structure than with the ZnO/CdZnS/$CuInSe_2$ or CdZnS/$CuInSe_2$ devices. During the past year we have concentrated on extending the $CuInGaSe_2$ deposition and the thin CdZnS solution growth to devices of 4 cm^2 area as a first step toward demonstrating $CuInGaSe_2$ based cells of larger areas. This essentially involved improving the reliability, reproducibility and uniformity of the $CuInGaSe_2$ deposition process and of the CdZnS growth process. 1 ref., 3 figs., 1 tab.

40523 (SERI/TP–211-3643, pp. 85-92) **Investigations of $CuInSe_2$ thin films and contacts.** Raud, S. (California Institute of Technology, Pasadena (USA)); Nicolet, M.A. Solar Energy Research Inst., Golden, CO (USA). Mar 1990. In *Photovoltaic Program Branch annual report, FY 1989.* Order Number DE90000318. Available from NTIS, PC A13/MF A01.

Solar cells made of CIS ($CuInSe_2$) polycrystalline thin films with close to 14% efficiency have been fabricated. The objective of this work is to investigate the microstructure, the contact stability between Mo and CIS in an effort to clarify limitation on these solar cells. The whole study was carried out with two kinds of samples provided by ARCO Solar Inc.: (1) CIS No. 1 films deposited on a glass substrate, and (2) CIS No. 2 films deposited on a Mo layer on a glass substrate. To investigate the stability of the metal/CIS interface by RBS, we have deposited thin Mo or W layers on the top of these samples using two techniques: rf magnetron sputtering and e-beam evaporation. Tungsten films were deposited in addition to Mo films because W has chemical, crystallographic, and electrical properties that are close to those Mo. But W has a heavier mass than Mo and this bypasses the overlapping problem of the Mo and In signals in the RBS spectra of a sample. We have carried out XTEM, SEM, EDX, and X-ray diffraction studies to obtain insights in the microstructure and defect chemistry of CIS. The interface stability after annealing at 600°C for 10 min. to 1 hour in argon atmosphere was investigated by RBS and X-ray diffraction. We have embedded the CIS films into epoxy and prepared cross-sectional TEM samples using a diamond knife. This technique is suspected to reduce important mechanical damage that may alter the film in an unspecified way. The study of the CIS No. 2 samples is less complete than that of the CIS No. 1 samples. The TEM observations of these cross sectional samples are provided. 2 refs., 5 figs.

40524 (SERI/TP–211-3643, pp. 93-97) **Analysis of loss mechanisms in polycrystalline thin-film solar cells.** Sites, J.R. (Colorado State Univ., Fort Collins (USA)); Mauk, P.H.; Tavakolian, H.; Sasala, R.A. Solar Energy Research Inst., Golden, CO (USA). Mar 1990. In *Photovoltaic Program Branch annual report, FY 1989.* Order Number DE90000318. Available from NTIS, PC A13/MF A01.

The objective is to design and demonstrate a system for routine, unambiguous, and quantitative analysis of loss mechanisms in individual polycrystalline solar cells. To be effective these procedures must be practical with equipment commonly available in solar cell laboratories and must be compatible with straightforward mathematical analysis. Three areas of analytical technique have undergone detailed examination and refinement. The first area is an accurate determination of the diode quality factor for non-ideal photo diodes. The procedure is to measure the slope of dV/dJ vs. ($J + J_L$), with correction for shunting effects when necessary. This technique allows one (1) to deal with large deviations from superposition, (2) to unambiguously separate the illuminated diode quality factor and the series resistance, and (3) to easily recognize the onset of current shunting or limiting effects. The second area is the use of the frequency and voltage dependence of capacitance to determine (1) carrier density, and hence Fermi level position, in the more lightly doped semiconductor, (2) width of the intrinsic layer often found adjacent to a polycrystalline heterojunction, and (3) density of extraneous states at the Fermi level in the depletion region. Reliable interpretation of the capacitance measurements requires continual monitoring of actual junction voltage, the real to imaginary impedance ratio, and the degree of voltage sweep hysteresis. The third area is the apparent quantum efficiency of a solar cell as a function of voltage. Quantum efficiency measurements are generally reliable input for photocurrent loss analysis when the forward current of the diode is small compared to the photogenerated current. All cells, however, exhibit major reductions in apparent quantum efficiency under forward bias. 4 refs., 3 figs.

40525 (SERI/TP–211-3643, pp. 98-103) **High efficiency cadmium and zinc telluride based thin film solar cells.** Rohatgi, A. (Georgia Institute of Technology, Atlanta (USA)); Summers, C.J.;

Erbil, A.; Sudharsanan, R.; Ringel, S.A. Solar Energy Research Inst., Golden, CO (USA). Mar 1990. In *Photovoltaic Program Branch annual report, FY 1989.* Order Number DE90000318. Available from NTIS, PC A13/MF A01.

The objective is to develop wide bandgap (1.6 -1.8 eV) polycrystalline thin films to be used as absorber material in the top-cell of the cascade cell structure. Target-cell efficiency for the wide bandgap cell is 10% with 80% subgap transmission. CdMnTe films are being grown by MOCVD while CdZnTe films are being deposited by MBE along with CdTe as a baseline material. CdTe and CdMnTe films were grown by metallorganic chemical vapor deposition (MOCVD) on glass/Sn 2/CdS substrates. CdMnTe films were grown using dimethylcadmium, diethyltellurium, as source materials for Cd and Te respectively and tricarbonyl methylcyclopentadienyl manganese and Bis-isopropylcyclopentadienyl manganese as source materials Mn. The CdMnTe films were grown at substrate temperature of 420 C, while CdTe films were grown at substrate temperature in the range of 300 to 400 C with diallyltellurium and diisoproyltellurium as sources for Te. CdZnTe and CdTe films were grown by MBE. Elemental sources were used instead of CdTe and ZnTe binary sources, with a purity of at least 5N. The substrate temperature was kept at 275 C for 30 minutes to commence film growth and increased to 300 C for the remainder of the run. Growth rates were typically ≈ 1 um/hr for both CdTe and CdZnTe. In selected instances Sb was used as a dopant and few attempts were made to grow -100 A thick CdTe interlayer between CdS and CdZnTe films to modify the interface quality. As-grown films were characterized by several techniques like X-ray diffraction (XRD), surface photovoltage (SPV), Auger electron spectroscopy (AES), Infrared spectroscopy (IR), and photoluminescence (PL) measurements to determine composition, bandgap, thickness, compositional uniformity, and quality. All the above measurements confirmed successful growth of CdMnTe and CdZnTe films with the bandgap of 1.7 eV with uniform composition. 5 figs.

40526 (SERI/TP–211-3643, pp. 47-49) **Diagnostics of glow discharges used to produce hydrogenated amorphous silicon films.** Gallagher, A. (National Institute of Standards and Technology, Boulder, CO (USA)); Doughty, D.A.; Doyle, J. Solar Energy Research Inst., Golden, CO (USA). Mar 1990. In *Photovoltaic Program Branch annual report, FY 1989.* Order Number DE90000318. Available from NTIS, PC A13/MF A01.

The overall objective of this work is to explain causes of glow-discharge produced a-Si:H and a-Si:Ge:H film quality, and its dependence on deposition discharge conditions. During this contract period this involved: (1) measuring substrate reaction probabilities, β, of depositing species in silane and silane-germane discharges as a function of conditions, (2) measuring the spatial distribution of deposition D(x) throughout silane, germane and silane-germane discharges under a variety of conditions relevant to a-Si:Ge:H film production, (3) interpreting these measurements to test and improve current deposition models, and explain causes of film-quality variations. The method developed and employed here to measure β is based on analogy to an optical black-body, in which almost all photons entering a small hole (area AH) in the side of a large box (surface area A_B) are absorbed before reescape, independent of the exact internal-surface absorption-coefficient k as long as k $A_B/A_H >> 1$. In the present context this translates into all reactive molecules that pass in through a small hole in the substrate being absorbed inside the box. In contrast, only a fraction β react on the substrate, so that β - $A_H t/T$, where t is the substrate film thickness A_H is the hole area and T is the total film deposited inside the box. We have found that p - 0.3 to 0.4 for T. 300-550 K in silane, disilane, and silane/germane discharge deposition of a-Si:H and a-Si:Ge:H, in rf discharges as well in at the substrate of a dc-triode discharge. In a pure-germane rf discharge we obtained p - 0.55, and at the cathode of a dc silane discharge p-0.6. All of these are surprisingly large p values from the standpoint of prior ideas regarding the cause of film morphology. 5 refs.

40527 (SERI/TP–211-3643, pp. 104-109) **Fundamentals of polycrystalline thin-film materials and devices.** Baron, B.N. (Univ. of Delaware, Newark (USA)); Birkmire, R.W.; Phillips, J.E.; McCandless, B.E.; Roy, M.; Shafarman, W.N. Solar Energy Research Inst., Golden, CO (USA). Mar 1990. In *Photovoltaic Program Branch annual report, FY 1989.* Order Number DE90000318. Available from NTIS, PC A13/MF A01.

The objective is to gain a deeper understanding of the materials, processing, and device issues needed to improve the performance, reliability, and cost of polycrystalline thin film solar cells. Procedures for fabricating device-quality $CuInSe_2$ thin films by selenization of Cu and In metal layers are being developed. The metal layers are deposited by electron beam evaporation. Selenization reactions of hydrogen selenide and elemental selenium are being studied. $CuInSe_2$ thin films are evaluated for chemical composition, structure, and morphology. Characterization of relevant opto-electronic properties of $CuInSe_2$ thin films is accomplished by fabrication and analysis of diagnostic $CuInSe_2$ Photovoltaic devices. Modifying the band gap of $CuInSe_2$ is investigated in order to reduce space charge recombination and increase open circuit voltage of $CuInSe_2$ solar cells. Approaches include alloying with Ga to form $CuIn_{1-x}Ga_xSe_2$ and graded band gap structures. $CuInSe_2$ devices with thin window layer and high transparency conductive oxide top contact layers are investigated to assess approaches to achieving high short circuit current. Emphasis is on thin CdS window layers deposited at low temperatures from aqueous solution and ZnO and ITO transparent top contact layers deposited by sputtering. $CuInSe_2$ thin film solar cells in a superstrate configuration - glass/transparent conductor/window layer/$CuInSe_2$/back contact - are being investigated. CdTe solar cells deposited by physical vapor deposition are being studied in order to understand the effects of post-deposition processing steps (e.g. heat treatments, chemical treatments and contacting) on material properties ad device performance. 3 refs., 3 figs.

40528 (SERI/TP–211-3643, pp. 110-114) **High efficiency $CuInSe_2$ and $CuInSe_2$-alloy cells.** Kapur, V.K. (International Solar Electric Technology, Inglewood, CA (USA)); Basol, B.M.; Kullberg, R.C. Solar Energy Research Inst., Golden, CO (USA). Mar 1990. In *Photovoltaic Program Branch annual report, FY 1989.* Order Number DE90000318. Available from NTIS, PC A13/MF A01.

The objective is to develop thin film $CuInSe_2$, (CIS) and CIS-alloy solar cells with conversion efficiencies approaching 12%. The technique used in preparing the CIS films is the two-stage process which consists of the selenization of Cu-In layers deposited on metalized substrates. E-beam evaporated Mo has been used as the back contact metal to the CIS-films. Our efforts were concentrated on evaporated/selenized CIS films. Results on high efficiency devices made on electrodeposited/selenized layers in our previous reports demonstrated small area cells with over 10% efficiency. However, adhesion of these CIS films to their Mo-coated substrates was poor and a problem for large area processing. During the present period of work we have totally eliminated the problem of poor adhesion by optimizing the evaporation/selenization approach. An electron-beam evaporator with a four-pocket hearth was used in this work. Cu and In films were sequentially deposited onto Mo coated glass (Corning 7859) substrates at a pressure of around $2x10^5$ Torr using 5-9's pure source materials. The Mo layers were also electron-beam evaporated. The typical thickness and sheet resistivity of a Mo layer were 2 um and 8.1 ohms/square respectively. After the evaporation step the substrates were placed in a tube furnace and the metallic layers were selenized in an atmosphere of H_2Se at 400 C for about 1 hour. The resulting films were analyzed using SEM, electron microprobe, and X-ray diffraction techniques. Solar cells were fabricated by depositing CdS/Transparent Conductive Oxide (TCO) window layers over the CIS films. CdS films were chemically formed on the CIS surfaces using an aqueous alkaline bath that consisted of 150 cc of 1M cadmium acetate, 75 cc of triethanolamine, 150 cc of ammonium hydroxide and 150 cc of 1M thiourea in 1 liter solution. 5 refs., 4 figs.

40529 (SERI/TP–211-3643, pp. 115-120) **High-efficiency, large-area CdTe panels.** Albright, S.P. (Photon Energy, Inc., El Paso, TX (USA)); Ackerman, B.; Chamberlin, R.R.; Jordan, J.F.; Singh, V.P. Solar Energy Research Inst., Golden, CO (USA). Mar 1990. In *Photovoltaic Program Branch annual report, FY 1989.* Order Number DE90000318. Available from NTIS, PC A13/MF A01.

The research effort has been directed toward development of an improved materials technology and fabrication processes for limited

volume production of 1 ft^2 and 4 ft^2 CdS/CdTe photovoltaic modules, with improved stability and improved efficiency being the most significant milestones. The research program has been separated into research tasks which include: (1) Efficiency improvement, (2) Large Area Panel Uniformity Improvement (3) Contact Passivation and Electrode improvement, (4) Encapsulation improvement and Long-Term Reliability Testing. Utilizing the results of these tasks progress has included device efficiency, module output improvement, and module reliability improvement. Electrical and optical measurements have been performed in order to assess the greatest potential areas for improvement in the process. It has earlier been concluded that the effects due to interface states or midgap recombination centers significantly affect performance. However, the 6 μ thick CdS window layer used in the PEI devices holds the greatest potential area for immediate efficiency improvement. Preliminary work on improved window materials has resulted in improved device efficiencies. 7 refs., 3 figs.

40530 (SERI/TP–211-3643, pp. 121-127) **Novel thin films $CuInSe_2$ fabrication.** Hermann, A.M. (Univ. of Arkansas, Fayetteville (USA)); Mooney, G.D. Solar Energy Research Inst., Golden, CO (USA). Mar 1990. In *Photovoltaic Program Branch annual report, FY 1989.* Order Number DE90000318. Available from NTIS, PC A13/MF A01.

The objective is to study the feasibility of fabricating $CuInSe_2$ (CIS) for use in photovoltaic cells by rapid annealing processes including laser processing and rapid thermal processing (RTP). Presently, the chalcopyrite phase of CIS is obtained by thermally annealing elemental Cu and In layers in H_2Se has. This type of selenization process is hazardous, however, because of the high toxicity of the hydrogen selenide gas. This feature makes the process unattractive for large-scale production because of the danger and expense incurred in handling the hydrogen selenide. The ability to form the desired chalcopyrite structure with favorable optical and electrical properties by rapid annealing processes would be safer and more conducive to large-scale production. Initial studies of the feasibility of laser annealing the elemental layered structures have been performed using a CW argon and Nd:Yag lasers on films that were fabricated by means of thermal resistance evaporation in a vacuum of 10^{-6} Torr. Characterization of the post-annealed films by x-ray diffraction analysis has shown encouraging results. The laser annealed films have all contained the chalcopyrite phase of CIS. The percentage of the chalcopyrite phase has been small however. The formation of undesirable binary compounds has also occurred. To produce higher quality films, future work will concentrate on increasing the percentage of the desirable phase and the elimination of all binary compounds. Initial studies of the feasibility of RTP have yielded the most encouraging rapid processing results to date. Characterization of post annealed films by X-ray diffraction analysis (XRD), thermoelectric power measurements (TEP), and microprobe analysis has shown that the desirable chalcopyrite structure has been formed in the RTP films over a wide range of temperatures and anneal times. 1 ref.

40531 (SERI/TP–211-3643, pp. 128-132) **Alternative fabrication techniques for high-efficiency $CuInSe_2$ and $CuInSe_2$-alloy films and cells.** Rockett, A. (Univ. of Illinois, Urbana (USA)); Banda, E.; Kenshole, G.; Talieh, H.; Campos, P. Solar Energy Research Inst., Golden, CO (USA). Mar 1990. In *Photovoltaic Program Branch annual report, FY 1989.* Order Number DE90000318. Available from NTIS, PC A13/MF A01.

The objective is to investigate $CuInSe_2$ thin film deposition techniques which are clearly scalable to large areas and which are capable of producing material suitable for solar cell applications. In addition, fundamental studies of $CuInSe_2$ are underway with the objective of learning how the $CuInSe_2$ materials properties contribute to the success or failure of solar cells. This understanding will serve to improve the processes under development, optimize deposition conditions, and ultimately to accelerate the return to service of large deposition facilities after periods of maintenance. Only magnetron sputtering is in common use for coating very large area substrates with thin films. This coating technology is well established for architectural glass applications, although evaporation has also been used to coat smaller-area surfaces. Both of the $CuInSe_2$ deposition methods considered by this project are based on sputtering techniques. Reactive sputtering of Cu and In in a mixed H_2Se + Ar atmosphere to produce $CuInSe_2$ has been examined in previous phases of the program. The current efforts center on a hybrid sputtering and evaporation technique. In this process Cu and In are sputtered with Ar gas while Se is supplied to the growing film by a conventional effusion cell. 1,2 The substrate temperature is controlled between room temperature and 450°C. The process has been shown to be straight forward to control with a linear relationship between the ion current ratio at the targets and the film composition established by previous results. Film compositions become slightly more Cu-rich as the substrate temperature is increased which appears to result from desorption of In_2Se from the film surface at elevated temperatures. The experiments underway focus development of a reasonably high efficiency $CuInSe_2$/CdS heterojunction solar cell. 6 refs., 2 figs.

40532 (SERI/TP–211-3643, pp. 133-135) **Thin film cadmium telluride, zinc telluride, and mercury zinc telluride solar cells.** Chu, T.L. (Univ. of South Florida, Tampa (USA)); Chu, S.S.; Britt, J.; Ferekides, C.; Kadamani, S.; Song, M.; Tseng, B.; Wu, C. Solar Energy Research Inst., Golden, CO (USA). Mar 1990. In *Photovoltaic Program Branch annual report, FY 1989.* Order Number DE90000318. Available from NTIS, PC A13/MF A01.

The major objective is to investigate the preparation, characterization, and optimization of thin-film cadmium telluride solar cells in order to demonstrate a quantum efficiency of 75% at 0.44 nm and a photovoltaic conversion efficiency of 11.5% or greater. In addition, thin film zinc telluride and mercury zinc telluride solar cells with photovoltaic conversion efficiencies of 5% and 8%, respectively, will be developed; thin film mercury zinc telluride solar cell is suitable as the top member in two-cell cascade structures. The cadmium telluride solar cell has the configuration: ohmic contact/p-CdTe/TCS (or n-CdTe/SnO_2)/glass substrate. The technical approach consists of (1) the deposition of a transparent conducting semiconductor (TCS) on a glass substrate, (2) the deposition of CdTe films by close-spaced sublimation (CSS) and metalorganic chemical vapor deposition (MOCVD), (3) the formation of ohmic contacts to p-CdTe films, and (4) the characterization and optimization of solar cells. Zinc telluride and mercury zinc telluride solar cells have a similar configuration as CdTe heterojunction cells, and zinc telluride and mercury zinc telluride films are deposited by metalorganic chemical vapor deposition (MOCVD). The photovoltaic characteristics of thin-film heterojunction solar cells depend strongly on the properties of TCS or heterojunction partner. Cadmium sulfide is the most commonly used TCS for CdTe solar cells; however, CdS has a bandgap of 2.42 eV, and thin films of 300 - 500 A in thickness should be used in order to minimize the above bandgap absorption. The growth of CdS films from aqueous solutions using the reaction of thiourea with cadmium acetate and ammonium hydroxide on the substrate surface is best suited for this purpose. The process parameters have been investigated, and the optical, crystallographic, chemical, and electrical properties of CdS films evaluated. 3 figs.

40533 (SERI/TP–211-3643, pp. 136) **Crystalline silicon materials research.** Benner, J.; Sopori, B. Solar Energy Research Inst., Golden, CO (USA). Mar 1990. In *Photovoltaic Program Branch annual report, FY 1989.* Order Number DE90000318. Available from NTIS, PC A13/MF A01.

Although crystalline silicon technologies for material growth and device processing are considered to be mature for a variety of applications, there remain a host of issues about which the current understanding is only marginal. These issues pertain to the role of defects and impurities in altering the properties of silicon and silicon solar cells. It is generally recognized that the presence of impurities/defects in the substrate can degrade the cell performance; however, recent data show that in the presence of crystal defects, the influence of impurities on the cell performance is somewhat mitigated. It is also known that some defects can be passivated by presence of hydrogen or oxygen, although a detailed knowledge of these effects is certainly lacking. Clearly, these issues are critical to photovoltaic technology based on use of low-cost substrates which contain high concentrations of impurities and/or defects. This research program is aimed at developing understanding of basic mechanisms related to influence of impurities

and defects on the important photovoltaic parameters in silicon. In processes that can be applied to low-cost substrates, preferably as a part of solar cell fabrication process, in order to improve subcontracts that are supported by SERI in-house research participation. Major areas of research are: (1) mechanisms of hydrogen, oxygen interaction in low-cost silicon; (2) mechanisms of hydrogen passivation and kinetics of hydrogen diffusion; (3) effects of hydrogen on solar cells containing different types of crystal defects; (4) development of techniques for impurity characterization in silicon containing crystal defects; and (5) nondestructive testing of the photovoltaic parameters of commercial material.

40534 (SERI/TP–211-3643, pp. 137-142) **Basic studies of point defects and their influence on solar cell related electronic properties of crystalline silicon.** Goesele, U.M. (Duke Univ., Durham, NC (USA)); Marioton, B.; Yang, W.S.; Taylor, W.J. Solar Energy Research Inst., Golden, CO (USA). Mar 1990. In *Photovoltaic Program Branch annual report, FY 1989.* Order Number DE90000318. Available from NTIS, PC A13/MF A01.

Agglomerates of oxygen, carbon, and intrinsic point defects together with dislocations are suspected to limit the minority carrier diffusion length in solar-grade crystalline silicon. The agglomeration of oxygen and carbon is associated with volume changes which may partly be accommodated by intrinsic point defects. In order to formulate a quantitative model of precipitation and agglomeration during crystal growth the thermal equilibrium concentration and the diffusivity of self interstitials, as well as the source/sink efficiency of dislocations for point defects have to be measured. Discussions cover: (1) influence of dislocations on point defect supersaturations, (2) investigations of dislocation efficiency, (3) determination of the diffusivity of silicon self-interstitials, and (4) the agglomeration model. 20 refs., 4 figs.

40535 (SERI/TP–211-3643, pp. 143-146) **Impurity and defect characterization in silicon.** Rohatgi, A. (Georgia Institute of Technology, Atlanta (USA)); Doolittle, W.A. Solar Energy Research Inst., Golden, CO (USA). Mar 1990. In *Photovoltaic Program Branch annual report, FY 1989.* Order Number DE90000318. Available from NTIS, PC A13/MF A01.

The objective is to characterize promising photovoltaic materials, develop a fundamental understanding of impurity effects, and provide guidelines for improving materials that are being developed under the SERI subcontracts. The materials/samples will be selected and supplied by the technical monitor at SERI. The work performed under this program will be two-fold: (i) establish appropriate procedures to apply various sophisticated measurement techniques to the samples provided by SERI and (ii) perform various measurements including DLTS, FTIR, PAS, and PL on defective materials and improve data interpretation. Understanding of defects is necessary to improve the quality of as-grown low-cost silicon substrates as well as post-growth processing procedures which can, concomitantly, lead to better cell performance. There is a lack of understanding of various important impurity-defect issues including: (i) kinetics of defects associated with high speed growth, (ii) influence of thermal treatments on the defect dynamics, (iii) interactions between impurities and defects, and (iv) passivation of impurity/defect activities. It is essential to carry out detailed analysis of the state of impurities in such substrates before and after various process steps. Information on changes in the defect and impurity concentrations and states in conjunction with other data from electrical analyses will be used to develop suitable models which can predict changes in the photovoltaic parameters caused by post-growth processes parameters. Research will be directed toward the understanding of kinetics of defects and impurities, along with some basic measurements of minority carrier lifetime. A model was developed to show the possible increase in performance of a solar cell when a small amount of oxygen precipitates at the grain boundary. 2 figs.

40536 (SERI/TP–211-3643, pp. 147-158) **Passivation and gettering studies in solar cell silicon.** Corbett, J.W.; Angell, D.; Awadelkarim, O.O.; Bakhru, H.; Baufeld, B.; Bestwick, T.D.; Borenstein, J.T.; Deak, P.; Gerasimenko, N.N.; Gibson, W.M. Solar Energy Research Inst., Golden, CO (USA). Mar 1990. In *Photovoltaic Program Branch annual report, FY 1989.* Order Number DE90000318. Available from NTIS, PC A13/MF A01.

This research program has two major aspects: (1) The study of hydrogen in crystalline silicon; and (2) the study of gettering in crystalline silicon. Hydrogen studies are concerned with all aspects of hydrogen in silicon: how hydrogen is introduced into silicon (by wet-etching, boiling, plasma treatment, injection from a Kaufman source, etc.); its configurations and diffusion mechanisms; and the nature of its interactions with defects; the main emphasis has been the modeling of the diffusion profiles. The gettering studies are concerned with mechanism by which deleterious impurities are introduced into silicon and the mechanism by which these impurities can be removed from the device region, e. g., removal at an external surface or at a precipitate. Using studies on radio-active copper we have established that copper can permeate into and diffuse in silicon at room temperature; we have begun studies of gettering of this element as well. 80 refs.

40537 (SERI/TP–211-3643, pp. 159-163) **The effectiveness and stability of impurity/defect interaction and their impact on minority carrier time.** Rozgonyi, G.A. (North Carolina State Univ., Raleigh (USA)); Shimura, F.; Tian Qun Zhou; Buczkowski, A.; Sopori, B. Solar Energy Research Inst., Golden, CO (USA). Mar 1990. In *Photovoltaic Program Branch annual report, FY 1989.* Order Number DE90000318. Available from NTIS, PC A13/MF A01.

The project is based on the chemical and electrical behavior of defect interfaces in crystalline silicon wafers, dendridic web and EFG ribbons as photovoltaic materials. Of particular interest at these interfaces is the practical issue of how stable a particular gettered element will be during subsequent thermal processing or device operation. We believe the fundamental aspects of gettering processes and the local improvement range of gettered material, or hydrogen deactivation, can be readily determined using a model epi/misfit dislocation system. This information will then be extended to EFG and web materials. The emphasis in this initial study has been on the hydrogen passivation of defects in silicon, particularly at pure or metal decorated dislocations. The primary tasks for the first year have been to investigate the effectiveness of hydrogen passivation of defects using epi/misfit dislocation silicon wafers and to determine if MCZ silicon wafers are equal, or superior to FZ and CZ silicon wafers in performance characteristics such as minority carrier lifetime, resistance to process induced defects and overall gettering capabilities. 5 refs., 5 figs.

40538 (SERI/TP–211-3643, pp. 164) **High-efficiency concepts.** Benner, J.; Leboeuf, C. Solar Energy Research Inst., Golden, CO (USA). Mar 1990. In *Photovoltaic Program Branch annual report, FY 1989.* Order Number DE90000318. Available from NTIS, PC A13/MF A01.

The objective is to evaluate and develop advanced photovoltaic technologies capable of energy conversion efficiencies in excess of 20% for flat-plate configurations and 30% in concentrator systems. These goals are discussed in the DOE Five-Year Research Plan as technology targets for the late 1990s. Even on this longer term horizon, it is difficult to envision a technology capable of achieving such high efficiencies without incorporating the demonstrated performance of crystalline III-V semiconductors. Thus, the High Efficiency Concepts task has become synonymous with III-V compound semiconductor research. The achievement of 25% efficiency in commercial concentrator modules will likely require production cells having more than 29% efficiency. The system cost target for that efficiency corresponds to cell costs less than $10/cm^2. At least three organizations have demonstrated single-junction GaAs cell at approximately this efficiency level. Recent successes in multiple-junction technologies show encouraging progress toward fulfilling the theoretical promise of providing commercial cells with more than 35% efficiency. However, a fivefold reduction in processing costs would be needed to meet the cell cost target for concentrator cells. Much of this reduction can be achieved through use of larger wafers and higher through-put deposition systems. Research supported by this program benefits future development efforts by strengthening the understanding of basic mechanisms which affect uniformity of doping, composition, and thickness over large area wafers, from wafer-to-wafer and from run-to-run. Efficient utilization of source materials and evaluation to potentially superior sources (cost, purity, control, safety, and other factors) are also important

topics for research. Continued improvement in cell efficiency is also a critical factor in reaching cost-effectiveness for the technology.

40539 (SERI/TP–211-3643, pp. 165-169) **High efficiency thin-film GaAs and ternary III-V solar cells.** Gale, R.P. (Kopin Corp., Taunton, MA (USA)); Fan, J.C.; McClelland, R.W.; King, B.D. Solar Energy Research Inst., Golden, CO (USA). Mar 1990. In *Photovoltaic Program Branch annual report, FY 1989.* Order Number DE90000318. Available from NTIS, PC A13/MF A01.

The objectives of this research program are to demonstrate large-areas and high-efficiencies in thin-film III-V solar cells. Kopin's approach is to use a thin-film technique (CLEFT) to produce high-efficiency single-crystal GaAs/AlGaAs cells less than 5 um thick. This very effective use of material coupled with the multiple reuse of the GaAs substrate will allow this approach to meet the Department of Energy's cell cost targets. Several key advances were achieved in FY89. The area of the thinfilm GaAs wafers processed was successfully increased a factor of two to 3 inch diameter, and our standard process converted to wafers of this large size. Thin-film cell efficiencies were improved to over 21.5% one-sun AM1.5 global on 4 cm^2 areas, with directions for further improvement identified. Monolithic interconnection with voltage addition of a four thin-film cell string was demonstrated, permitting further scale up of cell size with no loss of efficiency. A critical question on our approach was whether or not the CLEFT process can be scaled up to larger areas. In the last year we have doubled the wafer area in this process and found that not only can we scale up the process, but larger wafers are just as easy if not easier to fabricate than the smaller ones. We have observed no fundamental barriers to further increases in wafer size. 2 refs., 4 figs.

40540 (SERI/TP–211-3643, pp. 170-175) **Basic studies of III-V high-efficiency cell components.** Lundstrom, M.S. (Purdue Univ., West Lafayette, IN (USA)); Melloch, M.R.; Pierret, R.F.; Carpenter, M.S.; Keshavarzi, A.; Klausmeier-Brown, M.E.; Lush, G.B.; Stellwag, T.B. Solar Energy Research Inst., Golden, CO (USA). Mar 1990. In *Photovoltaic Program Branch annual report, FY 1989.* Order Number DE90000318. Available from NTIS, PC A13/MF A01.

Solar cell efficiencies are determined by material quality and device design. It is important to examine the physics of solar cells so that cell designs can be tailored to the material constraints. Our work is directed at understanding the physics and material parameters of compound semiconductor solar cells. We aim to identify the internal recombination losses that control the performance of state-of-the-art, high-efficiency GaAs based solar cells and to develop characterization methodologies and approaches that are broadly applicable to compound semiconductor cells. Another goal is to measure some of the fundamental parameters (such as the effective intrinsic carrier concentration and minority carrier mobility) which control the performance of solar cells. Our activities have focused on: (1) completing work on heavy doping effects in p^+-GaAs, (2) assessing the analogous effects in n^+-GaAs, (3) characterizing and controlling perimeter recombination, (4) understanding and further developing chemical passivation treatments, (5) conducting a baseline study of loss mechanisms in $Al_{0.2}Ga_{0.8}As$ solar cells, and (6) bringing on-line a new MBE growth facility. These tasks are summarized here and is described more fully in our annual report. Key results include: (1) extension of bandgap narrowing measurements in p^+-GaAs to one order of magnitude higher in doping, (2) demonstration that effective bandgap shrinkage is not an important factor in n^+-GaAs, (3) observation of an orientation-dependence to perimeter recombination, (4) demonstration that losses in both MOCVD- and MBE-grown $Al_{0.2}Ga_{0.8}As$ appear to be dominated by similar defects, and (5) successful turn-on and operation of a new MBE growth facility and the subsequent demonstration of GaAs solar cells with 23.8% conversion efficiency under 1-sun, AM1.5 global operating conditions. 8 refs. 3 figs.

40541 (SERI/TP–211-3643, pp. 176-179) **Research on semiconductors for high efficiency solar cells.** Borrego, J.M. (Rensselaer Polytechnic Institute, Troy, NY (USA)); Ghandhi, S.K. Solar Energy Research Inst., Golden, CO (USA). Mar 1990. In *Photovoltaic Program Branch annual report, FY 1989.* Order Number DE90000318. Available from NTIS, PC A13/MF A01.

The objective is to investigate problems in developing high efficiency single and multi-junction solar cells. Task one covers growth models and new reactor concepts and the development of computer programs directed to OMVPE in practical growth situations, and are capable of experimental verification. A computer program, which solves the Navier Stokes equations in two-dimensional form, was used to study convection in epitaxial reactors, and methods for the elimination of circulation effects. Since wall temperatures are calculated it is not necessary to use arbitrary boundary values for this parameter. Results have been directly applied to the growth of GaInAs, which is difficult because TEI and AsH_3 undergo a room temperature, parasitic, gas phase depletion reaction. Excellent material quality and uniformity were achieved at low reactor pressures and steep susceptor slopes and due to the presence (or absence) of convection effects. The effect of convection on the temperature field was studied for growth, with and without recirculation effects. Operation at low pressures reduces the amount of pre-heating of the gases. In GaInAs growth, it is important to minimize the effect of gas phase pre-reactions. Applying the computer program to stagnation point reactors resulted in the design of a new reaction chamber for growth of solar cell materials with high chemical usage efficiency. Task two is a study to extend analysis of growth mechanisms to growth in ternary systems of the II-Va-Vb type, where the sticking coefficient is less than unity for the column V compounds. Task three covers heterostructure mechanics. Most modern solar cell structures call for the heteroepitaxial growth of materials to give an increased photovoltaic conversion efficiency if the layers have good electrical quality. Task four cover materials studies and photoluminescence methods. Task five cover microwave diagnostics. 13 refs., 2 figs.

40542 (SERI/TP–211-3643, pp. 180-184) **Gallium arsenide based ternary compounds and multi-bandgap solar cell research.** Vernon, S.M. (Spire Corp., Bedford, MA (USA)); Tobin, S.P. Solar Energy Research Inst., Golden, CO (USA). Mar 1990. In *Photovoltaic Program Branch annual report, FY 1989.* Order Number DE90000318. Available from NTIS, PC A13/MF A01.

The goal is to establish a technology for producing very high efficiency solar cells for terrestrial photovoltaic applications using either multijunction or single-junction cell concepts. The approach taken involves the growth of GaAs or GaAs-based ternary materials onto GaAs or Si substrates by the metalorganic chemical vapor deposition (MOCVD) technique. The specific objectives were to improve the performance and understanding of GaAs homoepitaxial cells and of GaAs-on-Si heteroepitaxial cells; successes in both of these areas are described below. Our main focus this year has been on concentrator cells. We have achieved the demonstration of a GaAs-on-GaAs concentrator cell having an efficiency of 28.7% at 200X concentration, without the use of a prismatic coverglass. Our best one-sun efficiency has also climbed to the 24.8% mark. The factors that have led to these efficiency increases include improvements in the areas of cell design and fabrication as well as epitaxial growth. 14 refs., 4 figs.

40543 (SERI/TP–211-3643, pp. 185-189) **Advanced high-efficiency concentrator cells.** MacMillan, H.F.; Chung, B.C.; Hamaker, H.C.; Kaminar, N.R.; Kuryla, M.S.; Ladle, M.; Ristow, L.; Partain, L.D.; Schultz, J.C.; Virshup, G.F. Solar Energy Research Inst., Golden, CO (USA). Mar 1990. In *Photovoltaic Program Branch annual report, FY 1989.* Order Number DE90000318. Available from NTIS, PC A13/MF A01.

The objective is the development of a multijunction solar cell with a terrestrial power conversion efficiency of 35-40% at solar concentrations of 400 to 1000 AM1.5D. In order to meet the cost goals for utility-scale photovoltaic power systems, the multijunction cells are designed to be monolithic, two-terminal cells. The approach of this cell development effort encompasses the following key features. First, development strategy and device performance evaluation have been guided by our detailed, realistic computer model. The model predicts total cascade and component cell performance parameters from experimentally established input parameters, i.e., materials properties, device structure and operating conditions. Second, the III-V monolithic multijunction cells and interconnect materials are grown by computer-controlled organometallic chemical vapor deposition (MOCVD) on GaAs substrates. Third, the device fabrication utilizes standard wafer processing procedures for metallization and etching, which can be adapted to high throughput

manufacturing. Finally, the development sequence has been to first demonstrate the performance of the component cells and cell interconnects, and then to integrate these into a monolithic multijunction cell, initially for one-sun operation and then for operation under concentrated sunlight. 5 refs., 5 figs., 1 tab.

40544 (SERI/TP–211-3643, pp. 191-197) **The avalanche heterostructure and superlattice solar cell.** Summers, C.J. (Georgia Technological Research Institute, Atlanta (USA)); Rohatgi, A.; Torabi, A.; Rajavel, D.; Wagner, B.K.; Benz, R. II. Solar Energy Research Inst., Golden, CO (USA). Mar 1990. In *Photovoltaic Program Branch annual report, FY 1989.* Order Number DE90000318. Available from NTIS, PC A13/MF A01.

The objective is to assess both the potential of new material structures for enhanced solar cell performance, and to develop the technology of semiconductor material systems for testing these concepts. Device structures under study include the avalanche heterostructure and variably spaced superlattice photovoltaic device, modulation doped (nipi) superlattices and heteroface GaAs solar cells. To predict the performance and characteristics of an ideal avalanche heterostructure photodiode solar cell, the method used by Henry was developed to calculate the solar cell efficiency as a function of bandgap energy and sun concentration. In this model the smaller (n-side) bandgap energy, E_{G1} of the cell was assumed to control the I-V characteristics, while the bandgap ratio, g, between it, and the wider p-side bandgap energy, E_{G2}; and the electron impact ionization rate, ($1<\gamma<2$) were assumed to be the principal parameters controlling the increased collection efficiency of the cell. Cell design approaches within 5% of the ideal efficiencies predicted for a conventional heterojunction solar cell, 38 and 50%, respectively. Because this performance also depends on a very efficient ionization process, it appears unlikely that this concept can effectively compete with the other structures. For this reason, several other cell designs have also been investigated. 7 refs., 6 figs.

40545 (SERI/TP–211-3643, pp. 198-200) **Low cost technique for producing CdZnTe devices for cascade cell application.** Basol, B.M. (International Solar Electric Technology, Inglewood, CA (USA)); Kapur, V.K.; Kullberg, R.C. Solar Energy Research Inst., Golden, CO (USA). Mar 1990. In *Photovoltaic Program Branch annual report, FY 1989.* Order Number DE90000318. Available from NTIS, PC A13/MF A01.

The objective is to develop thin film CdZnTe devices with transparent contacts. The ultimate use of such devices will be in high efficiency tandem structures. The technique used in this program for obtaining the CdZnTe films is the two-stage process. The two-stage process consists of first depositing elemental layers of Cd, Zn and Te on a suitable substrate and then reacting these elemental layers to form the compound. During the first year of this program we had concentrated our efforts on the electrodeposition technique to obtain Cd, Zn and Te films. Plating conditions for each layer were determined and the compound films obtained by reacting these electroplated films were analyzed. During the present period of the program we have carried out work on evaporated/reacted compound films. The electrodeposition process is limited to the use of Te/Cd/Zn stacked layers due to the values of the plating potentials of these three elements. In evaporation, however, the order of deposition can be changed. A vacuum system and resistively heated Mo boats were used to deposit the Cd, Zn and Te films on transparent substrates. Both ITO coated glass and CdS/ITO/glass structures were used as substrates. Many of the initial experiments were carried out on CdTe films obtained by reacting Cd and Te films. Reaction temperatures changing from 350 C to 550 C were successfully used to obtain 1-1.5 micron thick CdTe films with smooth morphologies. Good quality ZnTe films were also obtained by reacting Zn and Te layers at temperatures ranging from 480 C to 550 C. In films containing both Cd and Zn, however, Zn was found to be distributed non-uniformly throughout the film. In these films Zn was found to be localized on the surface of the film possibly in the form of an oxide. 3 refs., 2 figs.

40546 (SERI/TP–211-3643, pp. 201-203) **Hydrogen radical enhanced growth of solar cells.** Borrego, J.M. (Rensselaer Polytechnic Institute, Troy, NY (USA)); Ghandhi, S.K. Solar Energy Research Inst., Golden, CO (USA). Mar 1990. In *Photovoltaic Program Branch annual report, FY 1989.* Order Number DE90000318. Available from NTIS, PC A13/MF A01.

The objective of this research is to grow InP in the presence of active radical species, and to characterize this material for solar cell applications. This effort falls under the New Ideas for Photovoltaic Energy Conversion program. Here, we proposed the use of hydrogen radicals to aid in the organometallic vapor phase epitaxial (OMVPE) growth process, in two ways. First, energy transferred to the alkyl and hydride species would provide a high electron temperature, allowing growth at a reduced thermal temperature. Second, these active species can be used to enhance substrate cleaning prior to growth. This, in turn, would allow growth at lower temperatures than those which are normally encountered in conventional OMVPE growth. The tasks undertaken on this program are: (1) reactor design and construction, (2) Microwave cavity design, (3) cleaning studies, (4) growth, and (5) characterization. 1 ref.

40547 (SERI/TP–211-3643, pp. 204) **University participation program.** Benner, J.; Leboeuf, C. Solar Energy Research Inst., Golden, CO (USA). Mar 1990. In *Photovoltaic Program Branch annual report, FY 1989.* Order Number DE90000318. Available from NTIS, PC A13/MF A01.

The objective of this program is to maximize the contribution of universities to the future of photovoltaic technology by focusing on the traditional needs and strengths of that community. Thus, it provides a forum in which the university researchers identify research topics critical to the advancement of photovoltaic technology with minimal influence from current programmatic interests. The selected participants are then permitted to pursue the Proposed basic and applied research ideas in an environment designed to foster creativity by limiting requirements for delivery of reports, samples and achievement of specific goals. Reporting is limited to annual reports and journal publications. Research Symposia organized by the participants, are held periodically and are open to all students, program participants, and outside researchers. The intent of the initiative is to provide continuity of funding over a minimum three-year period which will allow universities to build and support interdisciplinary teams with specialized expertise which can be applied to furthering the technology base of photovoltaic. Such a program is expected to attract the most highly qualified university research teams to the DOE National Photovoltaic Program. The University Participation Program also supports photovoltaic industry through the technology transfer which occurs not only by publication of research results in the technical literature, but also through enhanced student awareness of photovoltaic technology and education of future professionals.

40548 (SERI/TP–211-3643, pp. 205-210) **Rapid liquid phase epitaxy.** Gerritsen, H.J. (Brown Univ., Providence, RI (USA)); Crisman, E.E.; Daly, J.T.; Schaafsma, D.T.; Karlsson, S.K.F. Solar Energy Research Inst., Golden, CO (USA). Mar 1990. In *Photovoltaic Program Branch annual report, FY 1989.* Order Number DE90000318. Available from NTIS, PC A13/MF A01.

Single crystal layers of gallium arsenide have been grown on <111> and <100> oriented GaAs substrates using a flowing solution of gallium saturated with GaAs With this novel technique, growth rates as high as 9.0μm/min have been achieved for 5 minutes, while rates of approximately 4μm/min are typically achieved for 20 minutes of growth. These figures are in good agreement with a previously developed theoretical model and are about two orders of magnitude greater than those for conventional, static solution, liquid phase epitaxy (LPE) for layer thicknesses greater than 1μm. Undoped, p-doped and n-doped layers of high crystallographic and electronic quality have been grown. A description of the technique and some of the electro-optical properties are presented in this paper. 6 refs., 6 figs.

40549 (SERI/TP–211-3643, pp. 211-216) **Improvement of bulk and epitaxial III-V semiconductors for solar cells by creation and denuded recombination zones.** Milnes, A.G. (Carnegie Mellon Univ., Pittsburgh, PA (USA)); Schlesinger, T.E.; Pan, H.F.; Wong, D. Solar Energy Research Inst., Golden, CO (USA). Mar 1990. In *Photovoltaic Program Branch annual report, FY 1989.* Order Number DE90000318. Available from NTIS, PC A13/MF A01.

The performance of GaAs solar cells is often limited by short minority carrier diffusion lengths in the material. This is especially true of cells fabricated with active regions in bulk substrates, a consideration which has, in the past, necessitated the use of expensive epitaxial processing to achieve high efficiency cells. In FY89 CMU researchers have concentrated efforts on identifying the dominant recombination centers in bulk n-type GaAs and developing a simple process to suppress these recombination centers. The effects of annealing on defect structure and minority carrier diffusion lengths have been extensively characterized and insight has been gained on the anneal conditions which will yield optimal improvement. Zn diffused solar cells were fabricated directly in bulk substrates to demonstrate the impact of enhanced minority carrier diffusion lengths on the performance of solar cells which are made without any epitaxy. 9 refs., 4 figs.

40550 (SERI/TP–211-3643, pp. 217-222) **New approaches for high efficiency solar cell: Role of strained layer superlattices.** Bedair, S.M. (North Carolina State Univ., Raleigh (USA)); El-Masry, N.A. Solar Energy Research Inst., Golden, CO (USA). Mar 1990. In *Photovoltaic Program Branch annual report, FY 1989.* Order Number DE90000318. Available from NTIS, PC A13/MF A01.

The objective of the research program is to address current problems that are hindering progress towards achieving high efficiency cascade solar cell structures. Problems include proper interconnect between the two cells and the lack of compatible material systems for the optimum bandgap combinations. During the last year we have concentrated our activities on addressing potential techniques that can be used to reduce defects generated when incompatible material systems or poor quality substrates are being used in solar cells. In order to achieve such goals, we have carried out fundamental studies to understand the behavior of defects and dislocations in strained layer superlattices buffer films and the mechanisms involved in their reductions. These studies were carried out both experimentally and theoretically. 6 refs. 3 figs.

40551 (SERI/TP–211-3643, pp. 223-228) **Fundamental studies of defect generation in amorphous silicon alloys grown by remote plasma-enhanced chemical-vapor deposition (remote PECVD).** Lucovsky, G. (North Carolina State Univ., Raleigh (USA)); Nemanich, R.J.; Berhnole, J.; Parsons, G.; Whang, Cheng; Davidson, B.; Williams, M. Solar Energy Research Inst., Golden, CO (USA). Mar 1990. In *Photovoltaic Program Branch annual report, FY 1989.* Order Number DE90000318. Available from NTIS, PC A13/MF A01.

The research addresses issues relevant to the tasks that define Phase I of this three-year program. This research has been reported at the 1989 ICALS/ICAST Conferences/Asheville NC, August 1989; and has been submitted for presentation at the MRS Spring 1990-Amorphous Silicon Symposium. We have shown that if the incorporation of hydrogen in a-Si:H thin films is controlled by a surface reaction, as in the glow-discharge (GD) deposition process, reactive magnetron sputtering (RMS) and Remote PECVD, that: (i) the amount of hydrogen incorporated in the film is determined by an availability factor, that is characteristic of the particular deposition process, GD, RMS or Remote PECVD; and (ii) the substrate temperature, which determines the fraction of the available hydrogen atoms retained in the film at a given T_S. The distribution of bonded hydrogen between mono- and polyhydride bonding groups is determined primarily by the fraction of hydrogen incorporated under the particular combination of deposition conditions, and is not an intrinsic function of any of the deposition variables, as for example, the substrate temperature, T_S, the concentration or flow rate of SiH_4, etc. 8 figs.

40552 (SERI/TP–211-3643, pp. 233-238) **Defects and photocarrier processes in hydrogenated amorphous silicon alloys.** Schiff, E.A. (Syracuse Univ., NY (USA)); Antoniadis, H.; Hotaling, S.; Lee, Jung-Keun; Zafar, S. Solar Energy Research Inst., Golden, CO (USA). Mar 1990. In *Photovoltaic Program Branch annual report, FY 1989.* Order Number DE90000318. Available from NTIS, PC A13/MF A01.

The materials studied in this project are hydrogenated amorphous silicon-germanium alloys. The project aims to identify the defects which limit photovoltaic applications to these materials and to determine the origins of these defects. It is our intention that this work will either suggest strategies for improvement of these materials or establish that the defect densities are fundamental. The two principal research approaches are: (i) Studies the D-center defect in a-Si:H and a-$Si_{1-x}Ge_x$:H. Although it is generally accepted that there is a good correlation between the density of D-centers and the electron properties of these materials, there is as yet no satisfactory explanation for the processes which lead to defect creation during growth of hydrogenated amorphous alloys, nor for the subsequent degradation processes which have limited the efficiency of single-junction and tandem solar cells fabricated from these materials. The experimental research associated with this objective primarily involves electron spin resonance of the D-center; our silicon-germanium alloys have also been studied using infrared photomodulation spectroscopy by Tauc group at Brown University. These measurements have led us to investigate hydrogen-mediated defect density models for a-Si:H. At present our view is that hydrogen is involved in defect reactions in a-Si:H; our future research will attempt to better establish this view and to explore strategies for materials improvement based upon it. (ii) Studies of photocarrier transport and recombination. We seek to establish a complete picture for the evolution of photocarriers from photogeneration until recombination, and to relate this picture to deep level information obtained from electron spin resonance and other measurements. 18 refs., 4 figs.

40553 (SERI/TP–211-3643, pp. 239-244) **Low temperature MOCVD processes for high efficiency solar cells.** Dapkus, P.D.; Maa, B.Y.; Jeong, W.G.; Chen, Q.; Hummel, S.G. Solar Energy Research Inst., Golden, CO (USA). Mar 1990. In *Photovoltaic Program Branch annual report, FY 1989.* Order Number DE90000318. Available from NTIS, PC A13/MF A01.

Metalorganic chemical vapor deposition (MOCVD) is widely used to fabricate high efficiency III-V solar cells. The process has produced the highest efficiency solar cells to date and is unique in its ability to be scaled to large volumes. Despite these inherent advantages, MOCVD suffers certain disadvantages. Chief among these are that it is carried out at relatively high temperatures and that it inefficiently utilizes highly toxic precursors (ASH_3 and PH_3). These characteristics frustrate attempts to fabricate multijunction solar cells and create added hazard and cost. This program is directed to resolve these difficulties by providing a better understanding of the gas phase and surface kinetics of MOCVD, by exploring techniques for low temperature growth of III-V materials and device structures, and by exploring photo enhanced MOCVD processes. The activities of the previous three years of work have included basic studies of gas phase chemistry of organometallic III and V compounds, empirical studies of the reactions of organometallic on III-V surfaces in a dense gas phase medium, and empirical studies of the low temperature growth of III-V compounds by alternate supply of the III and V reactants – atomic layer epitaxy (ALE). The results of these studies are summarized. 19 refs., 3 figs.

40554 (SERI/TP–211-3643, pp. 245-250) **Electronic processes in thin film PV materials.** Taylor, P.C. (Univ. of Utah, Salt Lake City (USA)); Williams, G.A.; Ohlsen, W.D.; Nitta, S.; Lee, Gu, S.; Viohl, I. Solar Energy Research Inst., Golden, CO (USA). Mar 1990. In *Photovoltaic Program Branch annual report, FY 1989.* Order Number DE90000318. Available from NTIS, PC A13/MF A01.

In photovoltaic devices, especially those involving hydrogenated amorphous silicon (a-Si:H), the effects of defects, impurities and interfaces are very important in determining ultimate device performance. Knowledge of these three topics is particularly important for the optimization of PV devices. A second very important problem for PV devices employing a-Si:H is the stability of the optical and electronic properties. One must be able at least to characterize these metastabilities before devices can be effectively optimized. Under this subcontract optical and magnetic resonance techniques have been used to probe these significant questions. In addition to a-Si:H, there are several amorphous alloy systems which are potentially important for PV applications. These alloys include a-Si_xGe_{1-x}:H and A-Si_xC_{1-x}:H which are used for producing narrower gap materials for tandem cells and wider gap materials for top-surface p-layers, respectively. There are still significant problems with a detailed understanding of the defects and impurities which, among other effects, create enhanced densities of electronic

states in the gap in these films. This effort has involved four major scientific objectives. The first objective has been to understand the thermally- and optically-induced metastabilities in a-Si:H and related alloys using primarily electron spin resonance (ESR), nuclear magnetic resonance (NMR), optical absorption and photoluminescence (PL) as the experimental probes. The second and third objectives are to characterize deep gap defects, such as Si dangling bonds, and the general density of electronic states (DOS) in a-Si:H and related alloys. The fourth major objective involves the understanding of interfacial effects in a-Si:H and related alloys, especially as they relate to interfaces which are potentially important in PV devices. 8 refs., 2 figs.

40555 (SERI/TP–211-3643, pp. 229-232) **Ion-assisted deposition doping of p-CdTe.** Bube, R.H. (Stanford Univ., CA (USA)); Fahrenbruch, A.L.; Grimbergen, M.; Kim, D.; Lopez-Otero, A.; Sharps, P. Solar Energy Research Inst., Golden, CO (USA). Mar 1990. In *Photovoltaic Program Branch annual report, FY 1989.* Order Number DE90000318. Available from NTIS, PC A13/MF A01.

The purpose of this work is to investigate ion-assisted physical vapor deposition of p-CdTe and to determine the influence of co-deposition of ionized dopant atoms on the growth, structural, and photoelectronic properties of the deposited films. Primary problems for the utilization of polycrystalline p-CdTe based solar cells are those of obtaining sufficiently low series resistance and high V_{oc}. Sufficiently increasing the p-type doping density in the CdTe would lower both bulk and contact resistivity. Control of V_{oc} has been obtained by variation of the relative doping levels in CdS and CdTe for single-crystal based solar cells; thus control of p-type doping promises to be a tool for maximizing V_{oc} in polycrystalline cells as well. Many of the dopants successfully used in bulk semiconductor growth present problems in the case of film growth from the vapor due to low incorporation probabilities and/or surface segregation. However, impingement of low-energy dopant ions on the growing film during deposition can be used to significantly increase the sticking probability an/or incorporation of the dopant species. Our apparatus consists essentially of an ion source, a movable Faraday cup to monitor ion current, an effusion cell for CdTe, and a heated substrate holder, all situated in a vacuum system with a base pressure during deposition of $\approx 6 \times 10^{-8}$Torr. The ion source uses a BN Knudsen cell to supply the dopant atoms and an ionizer section with a W filament and a graphite anode and grid. Elemental As and P have been used as dopants. Epitaxial CdTe films were grown on single-crystal n- and p-CdTe substrates at typical rates of 0.1-0.3 μm/min and substrate temperatures T=300-500°C. Polycrystalline films on graphite and 7059 glass have also been grown. Significant results are discussed. 7 refs., 4 figs.

40556 (SERI/TP–211-3679) **Recent technological advances in thin film solar cells.** Ullal, H.S.; Zweibel, K.; Surek, T. Solar Energy Research Inst., Golden, CO (USA). Mar 1990. 5p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC02-83CH10093. (CONF-900901–1: World renewable energy congress, Reading (UK), 23-28 Sep 1990). Order Number DE90000321. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

High-efficiency, low-cost thin film solar cells are an exciting photovoltaic technology option for generating cost-effective electricity in 1995 and beyond. This paper reviews the substantial advances made by several thin film solar cell technologies, namely, amorphous silicon, copper indium diselenide, cadmium telluride, and polycrystalline silicon. Recent examples of utility demonstration projects of these emerging materials are also discussed. 8 refs., 4 figs.

40557 (SERI/TP–211-3830) **Research on the structural and electronic properties of defects in amorphous silicon: Annual subcontract report, July 1988–August 1989.** Street, R.A. (Xerox Palo Alto Research Center, CA (USA)); Boyce, J.B.; Jackson, W.B.; Johnson, N.; Ready, S.E.; Thompson, R.; Tsai, C.C.; Walker, J.; Winer, K. Solar Energy Research Inst., Golden, CO (USA); Xerox Palo Alto Research Center, CA (USA). Jun 1990. 54p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC02-83CH10093. Order Number DE90000342. Available from NTIS, PC A04/MF A01 - OSTI; GPO Dep.

The objective of this research program is to obtain a comprehensive understanding of the structure and electronic properties of a-Si:H. The main emphasis is on the phenomena of metastability and thermal equilibrium, in which the density of electronic states depend on the electronic and thermal history of the material. Metastability effects are a problem with solar cells and with other electronic devices. Our studies provide an understanding of the complex interaction between the electronic states and the atomic structure which cause these effects. One of the main materials problems of amorphous silicon technology is the phenomenon of metastability, in which the electronic properties depend on the thermal and electrical history of the sample. A key observation is that the defects are in thermal equilibrium with the disordered structure. The experiments confirm that defect equilibration occurs over a range of temperatures and sample deposition conditions. The relaxation time depends on the growth conditions, and the thermal defects are shown to anneal more slowly than optically induced defects. The temperature dependence of the thermodynamic equilibrium defect density is calculated, based on a hydrogen mediated weak-bond/dangling-bond conversion model. The distribution of defect formation energies is introduced by associating a different density of valence band tail states with each formation energy. A detailed analysis of the connection between hydrogen diffusion and the relaxation kinetics finds excellent agreement with the data. 17 refs., 24 figs.

40558 **High-efficiency $Al_{0.22}Ga_{0.78}As$ solar cells grown by molecular beam epitaxy.** Melloch, M.R. (School of Electrical Engineering, Purdue University, West Lafayette, Indiana 47907 (USA)); Tobin, S.P.; Bajgar, C.; Keshavarzi, A.; Stellwag, T.B.; Lush, G.B.; Lundstrom, M.S.; Emery, K. *Applied Physics Letters (USA),* 57(1): 52-54 (2 Jul 1990). Contract XL-5-05018-1;XL-8-18063-1.

The quality of *pn* junction photodetectors made of $Al_{0.2}Ga_{0.8}As$ has been investigated as a first step in the optimization of tandem solar cells. We have obtained 1 sun AM1.5 efficiencies of 16.1% for 0.25 cm^2 $Al_{0.22}Ga_{0.78}As$ solar cells fabricated from molecular beam epitaxy (MBE) material. This efficiency is 3.2 percentage points higher than the previously best reported efficiency of 12.9% for an $Al_{0.2}Ga_{0.8}As$ solar cell fabricated from MBE material.

1406 Photovoltaic Power Systems

Refer also to citation(s) 40506, 40507, 40508, 40509, 40510, 40511, 40512, 40513, 40514, 40515, 40516, 40517, 40518, 40519, 40520, 40521, 40522, 40523, 40524, 40525, 40526, 40527, 40528, 40529, 40530, 40531, 40532, 40533, 40534, 40535, 40536, 40537, 40538, 40539, 40540, 40541, 40542, 40543, 40544, 40545, 40546, 40547, 40548, 40549, 40550, 40551, 40552, 40553, 40554, 40555, 40866, 40958

40559 (EUR–11436) **The photovoltaic electrification of forty isolated houses in France. Demonstration project.** Kaut, W. (Commission of the European Communities, Luxembourg (LU)); Coroller, P. Commission of the European Communities, Luxembourg (Luxembourg). 1988. 103p. (In FR, EN). Available from NTIS (US Sales Only), PC A06/MF A01.

This report presents the current state of research into the electrification of rural areas by means of photovoltaic generators. By standardizing installations according to their levels of power, this programme has allowed the implementation of a policy of quality control over the components and the assessment on a meaningful scale of photovoltaic systems. The modules, batteries and undulators have been chosen for all the generators so as to standardize them and lower their cost. Two undulators have been specially developed through this programme which achieve a good return, a sine wave and reduced energy loss. More particularly, the report describes examples of forty houses in the South of France electrified as part of the programme, and describes the European market for energy production for isolated areas, its financial and administrative aspects, as well as the users' point of view. Examples of rural electrification and of the possible use of photovoltaic electrification in Italy, Spain, Portugal and in the French overseas territories will complete the study.

1407 Solar Thermal Power Systems

Refer also to citation(s) 40866

40560 (SAND–89-2964) **An interim report on testing the molten salt pump and valve loops.** Rush, E.E. (Sandia National Labs., Albuquerque, NM (USA)); Chavez, J.M.; Matthews, C.W.; Bator, P. Sandia National Labs., Albuquerque, NM (USA). Apr 1990. 34p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC04-76DP00789. Order Number DE90013609. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This interim report provides results of the molten salt pump and valve loop testing, lessons learned, and recommendations based on the test results to date. The molten salt pump and valve test loop is intended to demonstrate the effectiveness of full-scale hot and cold salt pumps and valves. The pump and valve testing consists of two pumped loops, one to simulate the hot side of the receiver (565°C, referred to as the hot loop) and one for the cold side (285°C, referred to as the cold loop). Each loop contains a pump and six representative valves scaled for a 60-MW_e commercial solar power plant using molten salt heat transport fluid. The test loop is part of the Molten Salt Subsystem/Component Test Experiment (MSS/CTE), which is being conducted to reduce the technical risk of building and operating commercial solar central receiver plants. The project, managed by Sandia National Laboratories (SNL) with Babcock and Wilcox (B&W) as the prime contractor, is cost shared by DOE and six contractors. The hot loop has operated over 2400 hours in the fully automatic sequence mode. The last 500 hours have been through continuous 24-hour, 7-day operation. The hot pump operation hours simulate over 2 years of pump cycles. The cold loop has operated 12 hours in the manual mode; this is because of problems caused in the manufacturing of the pump and motor. 9 refs., 6 figs., 1 tab.

1409 Solar Thermal Utilization

Refer also to citation(s) 40916

40561 (EUR–11063) **Solar heating of the Sportsco pool at Dublin. Demonstration project.** Hennessy, T.D. (Electricity Supply Board, Dublin, (IE)). Commission of the European Communities, Luxembourg (Luxembourg). 1987. 105p. Contract SEP/25/81-IR. Available from NTIS (US Sales Only), PC A06/MF A01.

This demonstration project involved the design, construction and operation of a solar panel installation, with extensive performance monitoring of the solar panels during two years of operation, 1984 and 1985. The installation consisted of 43 m of unglazed, uninsulated polypropylene panels manufactured by Robinson's Developments. The panels were designed to replace the use of direct electric pool water heating during the summer months, April to September inclusive. The disappointing results of the performance monitoring indicate that heating pool water, in Irish climatic conditions, is not a suitable application for this type of panel, where the pool water temperature is maintained at approximately 30°C. However, this is not a reflection on the basic technology; rather it indicates that other more suitable applications must be found. Daily efficiencies of collection of between 3.6 to 68.8% were recorded with an average value of 22% from the sample of days analyzed.

1410 Solar Collectors and Concentrators

Refer also to citation(s) 40561

40562 (ETDE/CH-mf–0507353) **Gross heat outputs and characteristic parameters of solar collectors: Test methods and results from the collector test periods 1978 to 1986.** Keller, J. (comp.) (Paul Scherrer Inst. (PSI), Villigen (Switzerland)); Rauber, M. (comp.). Paul Scherrer Inst. (PSI), Villigen (Switzerland); INFOSOLAR, Brugg (Switzerland). Oct 1989. 179p. (In German). Order Number DE90507353. Available from NTIS (US Sales Only), PC A09/MF A01.

Available from INFOSOLAR, P.O. Box 311, CH-5200 Brugg (Switzerland).

From 1978 to 1986 the Swiss Federal Institute for Reactor Research (EIR) - today Paul Scherrer Institute (PSI) - tested more than one hundred solar collectors using an outdoor test facility. Until 1984 the test results have been published yearly. As the number of the tested collectors decreased rapidly after 1983 it was decided to postpone the publication of the remaining test reports. The present final report is a summary of all test results obtained from 1978 to 1986. In 1987 the test activities were transferred to another institute. As soon as new test results are available, the publication of a supplement report is planned. (author) 12 figs.

40563 (ETDE/CH-mf–0507354) **Gross heat outputs and characteristic parameters of solar collectors: Abridged version of the collector test report, test periods 1978 to 1986. Explanatory comments, tables of test results, directory of addresses.** Keller, J. (comp.) (Paul Scherrer Inst. (PSI), Villigen (Switzerland)); Rauber, M. (comp.). Paul Scherrer Inst. (PSI), Villigen (Switzerland); INFOSOLAR, Brugg (Switzerland). Oct 1989. 50p. (In German). Order Number DE90507354. Available from NTIS (US Sales Only), PC A03/MF A01.

Available from INFOSOLAR, P.O. Box 311, CH-5200 Brugg (Switzerland).

From 1978 to 1986 the Swiss Federal Institute for Reactor Research (EIR) - today Paul Scherrer Institute (PSI) - tested more than one hundred solar collectors using an outdoor test facility. Until 1984 the test results have been published yearly. As the number of the tested collectors decreased rapidly after 1983 it was decided to postpone the publication of the remaining test reports. The present final report is a summary of all test results obtained from 1978 to 1986. In 1987 the test activities were transferred to another institute. As soon as new test results are available, the publication of a supplement report is planned. (author) 23 refs., 4 figs., 12 tabs.

40564 (N–90-21110) **The effect of leveling coatings on the atomic oxygen durability of solar concentrator surfaces.** Degroh, K.K.; Dever, T.M.; Quinn, W.F. National Aeronautics and Space Administration, Cleveland, OH (USA). Lewis Research Center. Apr 1990. 18p. (NASA-TM–102557;E–5375;NAS–1.15:102557;CONF-900419–: 8. international triennial conference on thin films and the 17th international conference on metallurgical coatings, San Diego, CA (USA), 1-6 Apr 1990). Available from NTIS, PC A03/MF A01.

Space power systems for Space Station Freedom will be exposed to the harsh environment of low earth orbit (LEO). Neutral atomic oxygen is the major constituent in LEO and has the potential of severely reducing the efficiency of solar dynamic power systems through degradation of the concentrator surfaces. Several transparent dielectric thin films have been found to provide atomic oxygen protection, but atomic oxygen undercutting at inherent defect sites is still a threat to solar dynamic power system survivability. Leveling coatings smooth microscopically rough surfaces, thus eliminating potential defect sites prone to oxidation attack on concentrator surfaces. The ability of leveling coatings to improve the atomic oxygen durability of concentrator surfaces was investigated. The application of a EPO-TEK 377 epoxy leveling coating on a graphite epoxy substrate resulted in an increase in solar specular reflectance, a decrease in the atomic oxygen defect density by an order of magnitude and a corresponding order of magnitude decrease in the percent loss of specular reflectance during atomic oxygen plasma ashing.

15 GEOTHERMAL ENERGY

1501 Resources and Availability

40565 (NEDO-P–8845) **Possibility investigation of small to medium scale geothermal power generation in Indonesia.** New Energy Development Organization, Tokyo (Japan). Jul 1989. 171p. (In Japanese). Order Number DE90507889. Available from NTIS (US Sales Only), PC A08/MF A01.

Together with the distribution of geothermal resource in Indonesia, was particularly investigated the possibility of small to medium scale geothermal development in Ulumbu geothermal region, Flores Island. Reserved geothermal resource is judged to be quantitatively sufficient for approx. OMW power generation. Though the

geothermal power generation, as necessitating the power transmission network to be arranged, was concluded to be less economical than the diesel power generation, individually made in the vicinity of consuming area, it, as accompanied with the electrification, traffic arrangement, etc. in a wide region, is judged to largely contribute to the local activation. Also in Indonesia, energy to replace oil is encouraged for the development with a strong interest in small to medium scale geothermal development in isolated islands. While headed by the above Ulumbu region, there exist many geothermal regions, suitable to such a development. For the promotion from now on, are cited lowering in cost for the investigation and development, selection of appropriate power generation method, and some other problems to be studied. 20 refs., 45 figs., 52 tabs.

1502 Geology and Hydrology of Geothermal Systems

40566 (LBL–28618-1/3) **A database for The Geysers geothermal field: Volume 1, Text and main figures.** Bodvarsson, G.S. (Lawrence Berkeley Lab., CA (USA)); Cox, B.L.; Fuller, P.; Ripperda, M.; Tulinius, H.; Witherspoon, P.A.; Goldstein, N.; Flexser, S.; Pruess, K.; Truesdell, A. Lawrence Berkeley Lab., CA (USA). Sep 1989. 97p. Sponsored by California State Lands Commission; U.S. DOE Conservation & Renewable Energy. DOE Contract AC03-76SF00098. Order Number DE90014001. Available from NTIS, PC A06/MF A01 - OSTI; GPO Dep.

In Fiscal Year 1985-1986 the Earth Sciences Division of Lawrence Berkeley Laboratory (LBL) began a multi-year project for SLC to organize and analyze the field data from The Geysers. In the first year, most of the work concentrated on the development of a comprehensive database for The Geysers, and conventional reservoir engineering analysis of the data. Essentially, all non-proprietary data for wells at The Geysers have been incorporated into the database, as well as proprietary data from wells located on State leases. In following years, a more detailed analysis of The Geysers data has been carried out. This report is a summary of the non- proprietary work performed in FY 1985–1986. It describes various aspects of the database and also includes: review sections on Field Development, Geology, Geophysics, Geochemistry and Reservoir Engineering. It should be emphasized that these background chapters were written in 1986, and therefore only summarize the information available at that time. The appendices contain individual plots of wellhead pressures, degree of superheat, steam flow rates, cumulative mass flows, injection rates and cumulative injection through 1988 for approximately 250 wells. All of the data contained in this report are non-proprietary, from State and non-State leases. The production/injection and heat flow data from the wells were obtained from the California State Division of Oil and gas (DOG) (courtesy of Dick Thomas). Most of the other data were obtained from SLC files in Sacramento (courtesy of Charles Priddy), or DOG files in Santa Rosa (courtesy of Ken Stelling). 159 refs., 23 figs., 3 tabs.

40567 (PB–90-211418/XAB) **Geology, distribution of hot springs and hydrothermal-alteration zones of major geothermal areas in Japan.** Kimbara, K.; Sakaguchi, K. Geological Survey of Japan, Tsukuba, Ibaraki (Japan). 1989. 489p. (REPT–270). Available from NTIS, PC A21/MF A03.

Text in Japanese; summary in English.

Compilation works on geology, distribution of hot springs and hydrothermal alteration zones were carried out for the assessment of geothermal resources in Japan. Following maps and related tables of twenty-eight major geothermal areas were prepared by the compilation works. The document contains simplified geologic map and cross section with gravity data, distribution map of hot and mineral springs, distribution map of hydrothermal alteration haloes, zonal distribution map of alteration zones, correlation table between geologic map and compilation data, catalogue for hot and mineral springs, and catalogue for hydrothermal alteration haloes.

1503 Geothermal Exploration and Exploration Technology

Refer also to citation(s) 40566

1509 Geothermal Engineering

Refer also to citation(s) 40566

1520 Geothermal Data and Theory

Refer also to citation(s) 40566

40568 (LBL–26899) **GTO-DOE/industry cost shared research: Microseismic characterization and monitoring.** Majer, E.L. Lawrence Berkeley Lab., CA (USA). Mar 1989. 5p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC03-76SF00098. (CONF-890352–11: US Department of Energy research and development for the geothermal marketplace: 7th geothermal program review, San Francisco, CA (USA), 21-23 Mar 1989). Order Number DE90014190. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The application of passive seismic studies in geothermal regions have undergone significant changes in the last 15 years. The primary application is now in the monitoring of subsurface processes, rather than exploration. A joint Geothermal Technology Organization (GTO) industry/DOE, monitoring project involving GEO, Unocal Geothermal, and LBL, was carried out at The Geysers geothermal field in northern California using a special high frequency monitoring system. This several-month-long experiment monitored the discrete and continuous seismic signals before, during, and after a fluid stimulation of a marginal production well. Almost 350,000 liters of water were pumped into the well over a four-hour, and a three-hour time period for two consecutive days in June of 1988. No significant changes in the background seismicity or the seismic noise were detected during the monitoring period. Analysis of the background seismicity did indicate that the earthquakes at The Geysers contain frequencies higher than 50 Hz and possibly as high as 100 Hz. 5 refs., 5 figs.

40569 (LBL–28618-2/3) **A database for the Geysers geothermal field: Volume 2, Appendix A, Steam flowrates and cumulative mass flows.** Bodvarsson, G.S. (Lawrence Berkeley Lab., CA (USA)); Cox, B.L.; Fuller, P.; Ripperda, M.; Tulinius, H.; Witherspoon, P.A.; Goldstein, N.; Flexser, S.; Pruess, K.; Truesdell, A. Lawrence Berkeley Lab., CA (USA). Sep 1989. 249p. Sponsored by California State Lands Commission; U.S. DOE Conservation & Renewable Energy. DOE Contract AC03-76SF00098. Order Number DE90013808. Available from NTIS, PC A11/MF A01 - OSTI; GPO Dep.

This document contains graphs of data collected from Geysers Geothermal Field. These graphs display data concerning steam rate and cumulative steam from 1968 to 1988. 245 figs. (FSD)

40570 (LBL–28618-3/3) **A database for the geysers geothermal field: Volume 3: Appendix B, Wellhead pressures and degree of superheat; Appendix C, Injection rates and cumulative injection.** Bodvarsson, G.S. (Lawrence Berkeley Lab., CA (USA)); Cox, B.L.; Fuller, P.; Ripperda, M.; Tulinius, H.; Witherspoon, P.A.; Goldstein, N.; Flexser, S.; Pruess, K.; Truesdell, A. Lawrence Berkeley Lab., CA (USA). Sep 1989. 257p. Sponsored by California State Lands Commission; U.S. DOE Conservation & Renewable Energy. DOE Contract AC03-76SF00098. Order Number DE90013811. Available from NTIS, PC A12/MF A01 - OSTI; GPO Dep.

This document contains graphs of data collected from Geysers Geothermal Field. These graphs display data concerning wellhead pressure and degrees of super heat from 1968 to 1988 in Appendix B; injection rate and cumulative injection rate in Appendix C. 255 figs. (FSD)

40571 **The not-so-rare earths.** Muecke, G.K.; Moeller, P. *Scientific American (USA),* 258(1): 72-77 (Jan 1988).

They are neither rare nor earths. Rare earths are metallic elements present in small concentrations in most minerals. The rare earths are essential constituents of advanced alloys, laser crystals, and the new high-temperature superconductors. They also catalyze the refining of petroleum. This paper reviews the abundance of rare earths and shows how data on rare earths can explain the geologic history of magmas and hydrothermal solutions.

17 WIND ENERGY

1705 Environmental Aspects

Refer also to citation(s) 40573

1706 Wind Energy Engineering

40572 (ECN-C–90-012) **Fatigue investigation into windturbine materials and blade joints.** Bach, P.W.; Schaap, B.A.J. Netherlands Energy Research Foundation, Petten (Netherlands). May 1990. 98p. (In Dutch). Contract NOVEM 41.33-017.40;Contract NOVEM 25.300-0350. Order Number DE90797105. Available from NTIS (US Sales Only), PC A05/MF A01.

The title materials concern glass fibre reinforced polyester plates, pen-hole joints and welded joints. From the constant amplitude tests of the plates it appears that apparently there is a fatigue limit for a low load (< 0.15 UTS) and a large number of load variations (> 1E9). The service life of fatigue tests with a representative load sequence (WISPER or wind spectrum reference) can be predicted rationally for the plates by means of a commom fatigue relation and a linear damage accumulation calculation. Just like for the pen-hole joints the predicted service life is conservative for the high load levels but for the lower load levels, which are important for practical conditions, the prediction is optimistic. The experimentally determined fatigue service lives of types of welded joints are compared with the NEN 2063 standard. It appears that this standard is conservative except for the high load levels. 21 figs., 5 tabs., 14 refs., 3 apps.

40573 (ECN-C–90-016) **Acoustic noise measurements on the VSH 20-WPX-PRT1 wind turbine rotor blades.** Van der Borg, N.J.C.M.; Vink, P.W. Netherlands Energy Research Foundation, Petten (Netherlands). May 1990. 21p. Contract NOVEM 24.300/1920;Contract CEC EN3W-0064-NL. Order Number DE90797106. Available from NTIS (US Sales Only), PC A03/MF A01.

In the framework of the FLEXHAT II program, experiments have been carried out with the VSH 20-WPX-PRT1 rotor blades, mounted on the rotor test facility '25 m HAWT' of ECN (Netherlands Energy Research Foundation). The rotor blades are equipped with passively controlled tips. Part of the program is the measurement of the acoustical characteristics of the rotor as a function of the rotational speed and corresponding tip angles. For this reason acoustic noise measurements have been performed by ECN on December 21, 1989, and on March 8, 1990. The results of this work are presented. In November 1988 acoustic noise measurements have been performed by FDO-TS on the VSH 20-WPX-THR rotor blades, also mounted on the 25 m HAWT. The results of this work have been presented elsewhere as measured sound pressure levels. This quantity is not only dependent on the acoustical characteristics but also on the measurement conditions. The results of the measurements of ECN are presented as acoustic source power levels. This quantity is only a characteristic of the turbine. For the purpose of comparison of the FDO-TS results with the ECN results, the FDO-TS results have been converted to source power levels. This has been done only for the measurement that has been performed in a situation comparable to the situation of one of the ECN measurements. 10 figs., 4 refs., 1 tab.

40574 (ETSU-N–116, pp. 1.1-1.16) **Aspects of unsteady aerodynamics in wind turbines.** Galbraith, R.A.McD. (Glasgow Univ. (GB). Dept. of Aerospace Engineering); Niven, A.J.; Coton, F.N. Energy Technology Support Unit, Harwell (UK); British Wind Energy Association, London (UK). Feb 1990. (CONF-9002126–: BWEA/DEN workshop on recent developments in the aerodynamics of wind turbines, Nottingham (UK), 21 Feb 1990). In *Recent development in the aerodynamics of wind turbines: Proceedings of a BWEA/DEN workshop held at Nottingham, UK, 21 February 1990.* Order Number DE90502034. Available from NTIS (US Sales Only), PC A02/MF A01.

Basic unsteady aerodynamics, VAWT performance modelling and passive stall regulation of VAWTs are examined. The aim of the presentation is to illustrate that, if desired, future wind turbine blades could be aerodynamically tailored to exploit the unsteady nature of the VAWT flow with far greater confidence and insight than has been hitherto possible. To this effect, the collaborating British research teams and, in particular, VAWT Ltd. have assembled sufficient knowledge for such a conclusion to be made. (author).

40575 (ETSU-N–116, pp. 2.1-2.16) **New aerofoils and some thoughts on wind turbine aerodynamics.** Garrad, A.D. (Flight Refuelling Ltd., Wimborne (UK)). Energy Technology Support Unit, Harwell (UK); British Wind Energy Association, London (UK). Feb 1990. (CONF-9002126–: BWEA/DEN workshop on recent developments in the aerodynamics of wind turbines, Nottingham (UK), 21 Feb 1990). In *Recent development in the aerodynamics of wind turbines: Proceedings of a BWEA/DEN workshop held at Nottingham, UK, 21 February 1990.* Order Number DE90502034. Available from NTIS (US Sales Only), PC A02/MF A01.

During the last five years there has been considerable activity on the design of new aerofoils for wind turbines. In the course of recent work some thought was devoted to preparing a detailed specification of an aerofoil designed for wind turbine use. This specification required some careful consideration of the duty of a wind turbine blade. At the same time work has been progressing on the nature of stall on a wind turbine rotor. The benefits to be derived from using a stall regulated machine, as opposed to a pitch regulated one are still uncertain but could be large and hence there is great interest in providing a pragmatic approach to the stall design problem. This combination of different requirements and activities in the wind turbine community makes it interesting to try and provide a summary of the present position in the industry into which the more academic research must fit. (author).

40576 (ETSU-N–116, pp. 3.1-3.13) **Experimental techniques for flow visualization on full scale wind turbines.** Pedersen, T.F. (Risoe National Lab., Roskilde (DK). Dept. of Meteorology and Wind Energy). Energy Technology Support Unit, Harwell (UK); British Wind Energy Association, London (UK). Feb 1990. (CONF-9002126–: BWEA/DEN workshop on recent developments in the aerodynamics of wind turbines, Nottingham (UK), 21 Feb 1990). In *Recent development in the aerodynamics of wind turbines: Proceedings of a BWEA/DEN workshop held at Nottingham, UK, 21 February 1990.* Order Number DE90502034. Available from NTIS (US Sales Only), PC A02/MF A01.

The recent years have shown a new interest in wind turbine aerodynamics. Several different techniques which are common for use in wind tunnels have been transfered to full scale wind turbine experiments. Some flow visualisation techniques seem to be very successful in use on wind turbines, while others are less successful. Use of smoke grenadtes is successful when looking at the general flow through the rotor and the wake pattern. Smoke grenades have been used to show the general flow pattern around and behind two wind turbine rotors. Some results of the visualized flow pattern are shown. Another interesting flow visualization technique is the oil flow technique. This technique is normally used to detect flow lines on models in wind tunnels and its use on rotating parts is considered less useful due to the centrifugal forces. A special viewing device developed to view the surface of the suction side of a wind turbine blade is described. (author).

40577 (ETSU-N–116, pp. 4.1-4.17) **HAWT aerodynamics in axial and yawed flow - experiment and theory.** Hales, R.H. (Cranfield Inst. of Tech., Bedford (UK). School of Mechanical Engineering); Bellia, J.M.; Rawlinson-Smith, R.I. Energy Technology Support Unit, Harwell (UK); British Wind Energy Association, London (UK). Feb 1990. (CONF-9002126–: BWEA/DEN workshop on recent developments in the aerodynamics of wind turbines, Nottingham (UK), 21 Feb 1990). In *Recent development in the aerodynamics of wind turbines: Proceedings of a BWEA/DEN workshop held at Nottingham, UK, 21 February 1990.* Order Number DE90502034. Available from NTIS (US Sales Only), PC A02/MF A01.

Pressure transducer measurements on a 3 m diameter HAWT will be presented; measurements at 45%R and 75%R are available. For the most part, the data was taken under the "steady" wind conditions of controlled-velocity tests, although some conventional field testing was also done. Analysis so far has concentrated on the aerodynamic response of the rotor (as measured by integrated

normal and chordwise forces, rotor power and yaw torque) at tip speed down to 2 and yaw angles from 0 to ± 45 degrees, covering the (dynamic) stall range. Separate theory has been developed for the steady (axial flow) and unsteady (yawed flow) cases. For the axial flow case, the theory includes a prescribed wake model, a boundary integral model to describe the inviscid flow at the rotor, extended to reflect the gross effects of TE separation, together with a 3D boundary layer model to indicate separation. (author).

40578 (ETSU-N–116, pp. 5.1-5.12) **The role of unsteady aerodynamics in vertical axis wind turbines.** Harris, Alan (Vertical Axis Wind Turbines Ltd., Henel Hempstead (UK)). Energy Technology Support Unit, Harwell (UK); British Wind Energy Association, London (UK). Feb 1990. (CONF-9002126–: BWEA/DEN workshop on recent developments in the aerodynamics of wind turbines, Nottingham (UK), 21 Feb 1990). In *Recent development in the aerodynamics of wind turbines: Proceedings of a BWEA/DEN workshop held at Nottingham, UK, 21 February 1990.* Order Number DE90502034. Available from NTIS (US Sales Only), PC A02/MF A01.

Continual refinement of the aerodynamic design and analysis tools available at VAWT Ltd. has been taking place in parallel with the development of new turbines and the availability of data from the VAWT 450 at Carmarthen Bay. The VAWT 450 project was funded by the Department of Energy and included an extensive monitoring programme from which the data presented here has been derived. Because stall regulated VAWT's at high wind speeds operate over a large amplitude of angle of attack, achieving massive separation at both extremes of the angle of attack range, it is important to understand the unsteady separated flow phenomena involved. Consequently, this paper presents some of the data measured on the VAWT 450 to illustrate typical flow behaviour, followed by details of some theoretical aerodynamic developments in the field of unsteady aerodynamics which provide further insight into the basic flow mechanisms. (author).

40579 (ETSU-N–116, pp. 6.1-6.12) **Measured airfoil characteristics of three blade segments on a 19 m HAWT rotor.** Madsen, H.A. (Risoe National Lab., Roskilde (Denmark)). Energy Technology Support Unit, Harwell (UK); British Wind Energy Association, London (UK). Feb 1990. (CONF-9002126–: BWEA/DEN workshop on recent developments in the aerodynamics of wind turbines, Nottingham (UK), 21 Feb 1990). In *Recent development in the aerodynamics of wind turbines: Proceedings of a BWEA/DEN workshop held at Nottingham, UK, 21 February 1990.* Order Number DE90502034. Available from NTIS (US Sales Only), PC A02/MF A01.

A standard 8.2 m blade (NACA 63_n - 2 nn airfoil sections) manufactured by LM, Denmark, has been modified so that three 0.5 m span blade segments at 37%, 68% and 97% radius, respectively, are singly hinged on a three component balance, attached to the main spar of the blade. The relative inflow velocity vector to the blade (magnitude and angle of attack) is measured by a five hole pitot tube, mounted on the blade about one chord length in front of the leading edge. A detailed description of this experimental set-up is presented along with measured airfoil characteristics for the three blade segments, both for the blade rotating and for the blade in standstill in high wind conditions. On the basis of these data the influence of unsteady effects and of 3D flow effects on the airfoil characteristics of a HAWT blade is discussed. (author).

40580 (ETSU-N–116, pp. 7.1-7.11) **Wind tunnel investigations into stalled behaviour of horizontal axis wind turbines.** Barnsley, M.J. (Southampton Univ. (UK)); Wellicome, J.F. Energy Technology Support Unit, Harwell (UK); British Wind Energy Association, London (UK). Feb 1990. (CONF-9002126–: BWEA/DEN workshop on recent developments in the aerodynamics of wind turbines, Nottingham (UK), 21 Feb 1990). In *Recent development in the aerodynamics of wind turbines: Proceedings of a BWEA/DEN workshop held at Nottingham, UK, 21 February 1990.* Order Number DE90502034. Available from NTIS (US Sales Only), PC A02/MF A01.

A 1m Horizontal Axis Wind Turbine has been built and tested in the Southampton University Low Speed Wind Tunnel as part of the UK Department of Energy program of wind energy research. The rig is equipped with a 2 bladed rotor of representative design and operated in the stall regulated (fixed pitch) mode. Blade surface pressures at 6 radial stations and 17 chordwise positions have been measured over a range of tip speed ratios from 6.3-4.2. Thrust and torque measurements have been made for the same conditions. Results so far give strong indications of delayed stall (high Cls) in the inner radii and increased power output when compared to a Blade Element Analysis at the onset of stall. A hydraulic control system has proved adequate at higher tip speeds and is being developed to extend stable operation into the fully stalled regime. Flow visualisation on the low pressure surface using liquid crystal coatings has revealed indications of separation lines which are not readily reconcilable with the corresponding pressure plots. (author).

40581 (ETSU-N–116, pp. 8.1-8.12) **Stall control of wind turbine blades.** Graham, J.M.R. (Imperial Coll., London (GB). Dept. of Aeronautics). Energy Technology Support Unit, Harwell (UK); British Wind Energy Association, London (UK). Feb 1990. (CONF-9002126–: BWEA/DEN workshop on recent developments in the aerodynamics of wind turbines, Nottingham (UK), 21 Feb 1990). In *Recent development in the aerodynamics of wind turbines: Proceedings of a BWEA/DEN workshop held at Nottingham, UK, 21 February 1990.* Order Number DE90502034. Available from NTIS (US Sales Only), PC A02/MF A01.

Some results from wind-tunnel experiments are reported. Results of a study of the development of stall on a twin bladed rotor are presented. Stall delay due to rotation (the Himmelskamp effect) is discussed. Also the lift and drag characteristics of five aerofoil sections from -5^0 to 40^0 angle of incidence with and without spoilers deployed on the suction surface of each aerofoil are presented. Examples of standard 10% chord flat plate spoilers deployed at 90^0 to the surface and a new design of leading edge spoiler are shown. (author).

40582 (ETSU-N–116, pp. 9.1-9.14) **Power regulation by means of aerodynamic control of vertical axis wind turbines.** Sharpe, D.J. (Queen Mary Coll., London (UK)); Sweeting, D.; Tan, C.C. Energy Technology Support Unit, Harwell (UK); British Wind Energy Association, London (UK). Feb 1990. (CONF-9002126–: BWEA/DEN workshop on recent developments in the aerodynamics of wind turbines, Nottingham (UK), 21 Feb 1990). In *Recent development in the aerodynamics of wind turbines: Proceedings of a BWEA/DEN workshop held at Nottingham, UK, 21 February 1990.* Order Number DE90502034. Available from NTIS (US Sales Only), PC A02/MF A01.

A theoretical investigation has been carried out to discover the extent to which various means of passive and active aerodynamic control can be used to regulate the power at high wind speeds of a straight blade vertical axis wind turbine. (author).

40583 (PNL–7357) **An evaluation of three models designed for siting wind turbines in areas of complex terrain.** Barnard, J.C. Pacific Northwest Lab., Richland, WA (USA). Jun 1990. 50p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC06-76RL01830. Order Number DE90013625. Available from NTIS, PC A04/MF A01 - OSTI; GPO Dep.

The aim of this study was to compare the ability of three micrositing models to simulate the wind flow in complex terrain. One of these models, NOABL, is a mass-consistent model while the other two, MS3DJH/3R and BZ, are descendants of Jackson-Hunt (J-H) theory. All three models were applied to two areas of complex terrain, Askervein Hill in Scotland and Altamont Pass in California. Askervein Hill is an isolated hill of moderate slope surrounded by a flat plain. In marked contrast, the terrain of Altamont Pass is very complicated and is aptly described as being very hilly. Over each modeled area, wind measurements taken from a relatively dense network of anemometry were used to assess the performance of the models by comparing these data to the model-derived winds. 20 refs., 13 figs., 7 tabs.

20 FOSSIL-FUELED POWER PLANTS

2001 Power Plants and Power Generation

Refer also to citation(s) 40276, 40306, 40317, 40980, 40981, 41495

40584 (ANL/EAIS/TM–15) **The effect of generating unit age on the cost and performance of US fossil-fired steam units: Phase one report, Estimating the effect of generating unit age on the performance of coal-fired steam units.** Corio, M.R.; Stokes, H.H.; South, D.W. Argonne National Lab., IL (USA). Environmental Assessment and Information Sciences Div. Jan 1990. 62p. Sponsored by U.S. DOE Fossil Energy. DOE Contract W-31109-ENG-38. Order Number DE90013536. Available from NTIS, PC A04/MF A01 - OSTI; GPO Dep.

The purpose of Phase 1 of this study is to quantify the effect of age on the performance of coal-fired units in the absence of life extension/betterment programs (i.e., beyond normal maintenance). Time-series cross-sectional unit-level data for the period 1964–1987 were used to estimate regressions relating the effect of age on equivalent forced-outage rate (EFOR), equivalent availability forced (EAF), and heat rate (HR). A sample of electric generating units representing about two-thirds of total US coal capacity in 1987 provided the basis for the regressions. The sample included roughly 570 subcritical units accounting for 5600 unit-years and 150 gigawatts (GW) and 100 supercritical units accounting for 1000 unit-years and 70 GW. An important feature of the study was to develop one model for both subcritical and supercritical units to control for various operating and design characteristics, and to profile the aging pattern of these units. The econometric models developed controlled for the effects of: age, capacity, design vintage or generation of design, boiler and furnace design, rest-of-plant design, coal quality, duty cycle, and life extension and plant betterment investments. The impact of life extension and plant betterment investments on the aging effect was controlled by identifying when their effect on operations and maintenance expenditures increased and by terminating the time-series analysis in that year. 6 refs., 8 figs., 12 tabs.

40585 (CONF-900306–1) **Estimating the effect of generating unit age on EFOR [equivalent forced outage rate] and EAF [equivalent availability factor] for coal-fired steam units operating between 1964 and 1981.** Corio, M.R. (Applied Economic Research Co., Inc., New York, NY (USA)); South, D.W; Stokes, H.H. Argonne National Lab., IL (USA). [1990]. 14p. Sponsored by U.S. DOE Fossil Energy. DOE Contract W-31109-ENG-38. From International symposium on performance improvement, retrofitting and repowering of fossil fuel power plants: GEN-UPGRADE '90; Washington, DC (USA); 6-9 Mar 1990. Order Number DE90013690. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This paper highlights results from Phase 1 of a study conducted for the US Department of Energy, wherein we estimated the effect of age on various performance indices associated with the US population of coal-fired steam generating units. Techno-economic relationships between age and (1) equivalent forced outage rate (EFOR), (2) equivalent availability factor (EAF), and (3) heat rate were estimated with time series, cross-sectional econometric models for the period 1964–1981. The effect of age on EFOR and EAF were found to be significant. Although the effects vary by the operating and design characteristics of the unit, some general patterns can be seen. In the first 28 years of operation, it was determined that EFOR deteriorates by 8–9% points due to age, without life extension/plant betterment programs. Improvement in EFOR after age 28 is attributable to a shift in duty cycle (baseload to cycling). The results of EAF with respect to age are similar to those found for EFOR. After an initial improvement, EAF deteriorates by 5–15% points by age 18, depending on steam pressure. 1 ref., 2 figs., 1 tab.

40586 (CONF-900801–22) **An advanced steam utility cycle for utility applications.** Berry, G.F. Argonne National Lab., IL (USA). [1990]. 6p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract W-31109-ENG-38. From 25. intersociety energy conversion engineering conference; Reno, NV (USA); 12-17 Aug 1990. Order Number DE90013894. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

To obtain an improved quantitative understanding of the effect of introducing a 1500 psig/1500°F steam into a utility environment a preliminary study (1 person month) was undertaken to assess this concept. This assessment was completed by performing the following tasks: (1) simulation of an existing 1465 psig/1000°F/1000°F steam cycle, (2) a simulation using turbine performance maps and advanced initial steam conditions, and (3) a simulation using new turbines (with turbine efficiencies similar to the existing turbines) and the advanced steam conditions. Several variations on these two concepts were investigated. The results of this assessment are as follows: (1) basecase turbine cycle efficiency was 41.48%, (2) a retrofit using advanced initial steam conditions (without reheat) resulted in turbine cycle efficiencies in the range of 44.11–44.27% and (3) a redesign using advanced initial steam conditions resulted in turbine cycle efficiencies in the range of 45.18–47.04%. 5 refs., 5 figs., 3 tabs.

40587 (DOE/MC/22182–2824) **Coal-fueled diesel systems for stationary power applications: Final report.** Little (Arthur D.), Inc., Cambridge, MA (USA). Sep 1988. 264p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC21-85MC22182. Order Number DE90000479. Available from NTIS, PC A12/MF A01 - OSTI; GPO Dep.

Once ultra-clean coal fuels become cost-competitive with oil and natural gas, the potential market for coal burning engine technology will be very strong indeed. As part of this contract, we conducted an assessment of the future market for coal-burning engines, which showed that their potential capacity growth in industrial cogeneration plants (2–20MW) and modular electric generating plants (5–30MW) could result in an increase in coal use of 3 to 6 million tons per year. The Copper-Bessemer coal engine system is a 3–6 MW, 360–400 rpm Model LSVB engine (substantially redesigned for coal) directly fired with engine-grade coal slurry. The engine has a bore of 15.5" and a stroke of 22", and is conservatively rated at 200 psi BMEP. The feedstock for the engine grade slurry will be high volatile bituminous coal. After cleaning, grinding, and slurrying, the engine fuel will have less than 0.5% ash, 1% sulfur and will pump and flow similarly to diesel fuel. For emissions control, the engine system will include a three component system, including the reduction of NO_x. The two applications must suitable for this coal-fired engine are Industrial Cogeneration Plants (2–20MW), and Modular Electric Generating plants (5–30MW). There is an opportunity for coal-fueled engines because neither of these applications can be served very cost-effectively by larger coal-fueled power technologies, such as coal-gasification with combined-cycle turbine or the steam turbine with fluidized bed boiler. This report focuses on engine preparation, test, supporting research on injection, wear, and reassment of of previous tasks. 17 refs., 50 figs., 45 tabs.

40588 (EPRI-GS–6825) **Magnetohydrodynamic (MHD) power plant interface engineering: Final report.** Van Bibber, L.E. (Westinghouse Electric Corp., Pittsburgh, PA (USA). Advanced Energy Systems Div.); Wiseman, D.A.; Cuchens, J.W. Electric Power Research Inst., Palo Alto, CA (USA); Westinghouse Electric Corp., Pittsburgh, PA (USA). Advanced Energy Systems Div.; Southern Electric International, Birmingham, AL (USA). ©Jul 1990. 104p. Sponsored by Electric Power Research Institute. Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

This report summarizes the results of EPRI Research Project 2466-10. The objective of this project was to identify the preliminary interface requirements and characteristics for a coal-fired magnetohydrodynamic retrofit power plant located at the Scholz Generating Station, Sneads, Florida. An initial building arrangement has been developed and incorporated into the plot plan of the Scholz Generating Station. An MHD process flow diagram was generated and integrated with the existing plant process flow diagram. The electrical interface schematic for the MHD system was also developed. A preliminary list of process flow, electrical, and physical interfaces was produced and the respective interface requirements defined. The existing facilities were inspected and the necessary modifications imposed by the MHD system have been identified. 6 refs., 24 figs., 11 tabs.

40589 (EPRI-GS–6868) **Preliminary guidelines for integrated controls and monitoring for fossil fuel plants.** McKinley, J.H. (Southern California Edison Co., Rosemead, CA (USA)); Papilla, R.P.; Shendrikar, U.D.; White, T.H.; Winarski, C.P. Electric Power Research Inst., Palo Alto, CA (USA); Southern California Edison Co., Rosemead, CA (USA). ©Jun 1990. 102p. Sponsored by Electric Power Research Institute. Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

These guidelines outline the ways in which a state-of-the-art digital Distributed Control System (DCS) can improve plant performance and summarize options to be considered when conducting control system upgrades and changeouts. They emphasize the opportunity to integrate related diagnostic and monitoring systems such as performance monitoring, boiler and turbine stress monitoring, vibration monitoring, and tube leak monitoring. Integration of two partial DCS systems from different suppliers is also considered. The guidelines are divided into 27 topics. Each topic deals with one aspect of scoping a controls retrofit project. Each is a very concise statement of recommended integration philosophy, design criteria, and specifications to take full advantage of the integrated potential of a DCS. Cost information is provided where possible. Many utilities are planning to upgrade or replace the control systems on one or more generating units. The guidelines present a comprehensive approach for a retrofit project. Some integrable features may not be cost justified for smaller projects. However, the project should benefit from having considered them. Southern California Edison will follow the guidelines as it executes the El Segundo 3 and 4 Controls Retrofit Project. The results of the demonstration project will be incorporated with the latest considerations for planning a controls retrofit project in the final guidelines which will be published in 1991. 5 refs.

40590 (EPRI-GS–6904) **Evaluation of a Dow-based gasification-combined-cycle plant using bituminous coal: Final report.** Hager, R.L. (Fluor Daniel, Inc., Irvine, CA (USA)); Heaven, D.L. Electric Power Research Inst., Palo Alto, CA (USA); Fluor Daniel, Inc., Irvine, CA (USA). ©Jun 1990. 198p. Sponsored by Electric Power Research Institute. Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

The Electric Power Research Institute (EPRI) has sponsored a series of engineering and economic evaluations for a number of gasification processes, with an emphasis on second-generation technologies. This report presents the results of a detailed evaluation of the Dow Coal Gasification Process applied to a staged, integrated combined-cycle power plant. Dow's process was evaluated because it offers very attractive performance features while retaining the simplicity of a slurry-fed entrained gasifier. Dow has been operating a 24000 t/d commercial scale demonstration unit in Plaquemine, Louisiana since April 1987. The plant feedstock is a low sulfur subbituminous coal, and through October 1989 the plant gasified 800,000 tons of coal. Consecutive 30 and 90 day production records achieved to date are at an 88 and 69 percent capacity factor respectively. Eleven thousand tons of bituminous coal from Southern Utah have also been successfully gasified during March and May 1989 test runs. A plant design and cost estimate was done for a Dow-based, staged construction IGCC plant employing GE 7F combustion turbines located in the Mid-Atlantic region. Primary plant fuels are No. 2 fuel oil during the simple and combined cycle stages and Eastern bituminous coal during the gasification stage. A financial analysis investigating the effects of coal price and capacity factor was also performed. 7 figs., 28 tabs.

2002 Waste Management

Refer also to citation(s) 40272, 40321, 40322, 40337, 40587, 40588

40591 (CRIE-T–89017) **Development of high efficient ESP for submicron particle collection.: Agglomeration effect and collection efficiency of an electrostatic precipitator combined with an electrostatic agglomeration apparatus.** Watanabe, T.; Suda, T. Central Research Inst. of Electric Power Industry, Komae, Tokyo (Japan). Energy and Environment Lab. Nov 1989. 36p. (In Japanese). Order Number DE90507868. Available from NTIS (US Sales Only), PC A03/MF A01.

The result of testing the operation of an electrostatic agglomeration appratus (ESA) is reported, which has been developed at Central Research Institute of Electric Power Industry (CRIEPI). Details of the apparatus is given in the authors ' previous papaer (1988). At first a description is given of an apparatus which produces the aerosol for laboratory use comprising submicron-sized carbon particles and micron-sized flyash particles. This aerosol is similar in quality to that produced by a combustion furnance at CRIEPI. An apparatus provided with mesh electrodes for charging aerosol particles is also developed. Thus preparing aerosol samples, the effect of agglomeration produced by the ESA On the samples is examined to demonstrate that particle sizes in diameter are increased by a factor of four on average and the percentage of submicron-sized particles (less than 1 μ m in diameter) is reduced by 20% in weight. Combined with this type of ESA, the efficiency of ESP (electrostatic precipitator) in collecting submicron-sized particles is theoretically calculated to increase by about 1 - 3% when it is used at a thermal power plant of 520MW. 4refs., 21 figs., 6 tabs.

40592 (CRIE-W–89016) **Study of power generation systems for CO_2 collection.: LNG combined cycle.** Moritsuka, H.; Hamamatsu, T.; Ishikawa, H. Central Research Inst. of Electric Power Industry, Tokyo (Japan). Oct 1989. 34p. (In Japanese). Order Number DE90507881. Available from NTIS (US Sales Only), PC A03/MF A01.

Power generation system for CO_2 collection was studied. When a pressure swing adsorption method is used to separate CO_2 from exhaust gas of conventional power plant (LNG combined cycle power plant), three stage process is required and 5.1% power of total power generation is consumed. For CO_2 closed reheat gas turbine combined cycle power generation system where oxygen is used to combust fuel and to avoid nitrogen mixture in exhaust gas by oxygen blow out, net generation efficiency is 36.8% owing to oxygen generation and power plant consumtion. For a LNG reformed CO removal combined cycle power generating system where hydrogen is separared from LNG reformed gas to supply to gas turbine and remained CO is combusted in the reformer to collect CO_2, net generation efficiency is 38.5% after subtracting powere to generate oxygen and power consumed in the power plant. For a LNG reformed MC type fuel cell power generation system where LNG is reformed to supply fuel to the MC type fuel cell and oxygen is supplied to oxygen pole, final net generation efficiency becomes 49.2%, indicating very high efficiency. 5 refs., 13 figs., 2 tabs.

40593 (DOE/FE–0191P) **Comprehensive report to Congress: Clean coal technology program: 180 MWe demonstration of advanced tangentially-fired combustion techniques for the reduction of nitrogen oxide (NO_x) emissions from coal-fired boilers.** USDOE Assistant Secretary for Fossil Energy, Washington, DC (USA). Office of Clean Coal Technology. Jul 1990. 40p. Sponsored by U.S. DOE Fossil Energy. Order Number DE90013591. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

In December 1987, Public Law No. 100-202, as amended by Public Law No. 100-446, provided $575 million to conduct cost-shared Innovative Clean Coal Technology (ICCT) projects to demonstrate emerging clean coal technologies that are capable of retrofitting or repowering existing facilities. One of the selected proposals is the Southern Company Services, Inc's (SCS) proposal to demonstrate advanced tangentially-fired combustion techniques in a 180 MWe power plant. It will demonstrate the reduction of NO_x emissions from pulverized coal-fired boilers by the use of three combustion control techniques; the Low NO_x Concentric Firing System (LNCFS), Advanced Overfire Air (AOFA), and the Combustion Engineering (CE) Concentric Clustered Tangential Firing System (CCTFS). AOFA involves improving the mixing of overfire air with the furnace gases to achieve complete combustion, and the depletion of air from the burner zone to minimize NO_x formation. This technique is estimated to reduce NO_x in tangentially-fired boilers by about 30%. 9 figs., 1 tab.

40594 (EPRI-GS–6819-Vol.1) **Texaco coal gasification wastewater handling and treatment pilot plant: Volume 1, Performance summary: Final report.** Klock, B.V. (Texaco, Inc., Port

Arthur, TX (USA). Port Arthur Research Labs.); Vuong, D.C.; Webster, G.H. Electric Power Research Inst., Palo Alto, CA (USA); Texaco, Inc., Port Arthur, TX (USA). Port Arthur Research Labs. ©Jul 1990. 81p. Sponsored by Electric Power Research Institute. Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

The Cool Water Coal Gasification Program (CWCGP) provided the first commercial scale demonstration of Integrated Gasification Combined Cycle (IGCC) power production from coal. Water treating at Cool Water was simplified by the plant's location in the Mojave desert which allowed the use of evaporation ponds. Because most utilities will not be able to dispose of plant wastewater in evaporation ponds, a water treating pilot plant was installed at Cool Water to provide a basis for the design of future effluent treatment facilities. All of the pilot plant's equipment and operations costs were paid by Texaco. The overall treatment results were sponsored by EPRI and are being made available to member utilities in this report. The pilot plant test, which processes wastewater from the gasification of SUFCo coal, were conducted during the first four months of 1989. The wastewater (grey water) was characterized by the presence of cyanide, sulfide, ammonia, coal ash particles, and formate. The Texaco process removed these constituents from the wastewater by: (1) reacting cyanide and sulfide with ferrous iron; (2) settling and filtering out the solids; (3) steam stripping the ammonia; and (4) biologically treating for formate. The work showed that the Texaco Gasification Wastewater Treatment Process (TGWTP) can be utilized to treat Texaco coal gasification plant wastewater to very low contaminant levels. The work also indicated that a reduction in water treatment capital cost can be obtained by concentrating the wastewater prior to treatment.

40595 (EPRI-GS–6819-Vol.2) **Texaco Coal Gasification Wastewater Handling and Treatment Pilot Plant: Volume 2, Wastewater sampling and analysis: Final report.** Dille, R.M. (Dille (R.M.), Port Arthur, TX (USA)). Electric Power Research Inst., Palo Alto, CA (USA); Radian Corp., Austin, TX (USA). ©Jul 1990. 251p. Sponsored by Electric Power Research Institute. Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

Radian was contracted by the Electric Power Research Institute to collect and analyze water, sludge, and vapor samples associated with the pilot study of the Texaco coal gasification wastewater process. The pilot plant tests, processing grey water produced from the gasification of SUFCO coal, were conducted at the Cool Water Coal Gasification Program (CWCGP) facility during the first four months of 1989. Radian collected samples of the pilot plant streams for three test runs: January 8 through January 13, March 27 through March 31, and April 23 through April 30, 1989. There were two sampling periods in each test run. The CWCGP wastewater (grey water) is characterized by the presence of cyanide, sulfide, ammonia, coal ash particles, and formate. The Texaco process is designed to remove these constituents by: (1) reacting cyanide and sulfide with ferrous iron; (2) settling and filtering the solids; (3) steam stripping the ammonia; and (4) biologically treating for formate. Samples collected to characterize the wastewater treatment process were the influent water, effluent water, iron sludge, biological sludge, and stripper overhead gas condensate. All samples were collected as aqueous or solid grab samples and analyzed by approved methods. Ammonia, solids, and formate removal were demonstrated in all three test runs. The best cyanide removals were demonstrated during Runs 2 and 3 when effluent cyanide concentrations decreased by a factor of 10, compared to the influent levels, as a result of the wastewater treatment. Sulfide removal was most clearly observed during Run 1. Very low sulfide concentrations (at or near the detection limit) in the influent stream precluded estimates of sulfide removal during Runs 2 and 3.

40596 (ETSU-EEP–1) **Gaseous emissions due to electricity fuel cycles in the UK.** Eyre, N.J. AEA Technology, Harwell (UK). Energy and Environment. Mar 1990. 31p. Order Number DE90508768. Available from NTIS (US Sales Only), PC A03/MF A01.

Energy supply and use results in majo environmental impacts. A range of technical options are available for reducing impacts - notably fuel switching, pollution control and improved efficiency. Any objective analysis of the impacts or the abatement options must start from a reliable estimate of the environmental burdens from each fuel cycle. This report describes the emissions resulting from the extraction, processing, transport and use of fuels for electricity production. It covers the principal gaseous emissions responsible for global, regional and local air pollution. For each process stage, the efficiency and emissions associated with typical UK technology and operating practices are evaluated. Emission factors for each fuel are presented separately for each process stage and as a total for the complete fuel cycle. A procedure for comparing the effects on global warming of carbon dioxide and other greenhouse gases is presented. Greenhouse gas emissions due to use of UK public supply electricity are equivalent to 68 Mte C of Co_2. Electricity fuel cycles emit 24% of all UK greenhouse gases. A composite indicator for acid emissions is derived and it is concluded that the electricity sector emits 62% of the UK total. The emissions of typical UK coal and oil fuel cycles would be reduced by 80% using coal with modern emission controls or by 90% with gas combined cycle generation. (author).

40597 (ETSU-EEP–2) **The abatement of gaseous emissions by energy efficient lighting.** Eyre, N.J. AEA Technology, Harwell (UK). Energy and Environment. Mar 1990. 30p. Order Number DE90508769. Available from NTIS (US Sales Only), PC A03/MF A01.

This paper assesses the scope for using existing technologies to improve the energy efficiency of lighting in the UK. The key technologies are identified separately for the domestic, service and industrial sectors. The cost effectiveness of each measure is assessed and most of the technically possible measures are found to be economically attractive. It would appear that market penetration is being constrained mainly by problems of availability, information and emphasis on purchase costs. The minimum potential reduction in Co_2 emissions due to cost effective lighting is calculated to be 3,270 kte/year (carbon as CO_2). This is equivalent to 2% of UK CO_2 emissions. When the emissions of other greenhouse gases are included, the potential for the reduction in greenhouse gases (expressed in terms of Co_2 equivalent) is 3,950 kte/year. The effect on emissions of SO_2 and NO_x is more marked. These would be reduced by 100 kte/year and 22 kte/year respectively. This is equivalent to 5% of current acid emissions. (author).

40598 (PB–90-216441/XAB) **Evaluation of the E-SOx process on the EPA pilot electrostatic precipitator. Final report, November 1986-September 1988.** Hovis, L.S. Environmental Protection Agency, Research Triangle Park, NC (USA). Air and Energy Engineering Research Lab. May 1990. 59p. (EPA–600/7-90/011). Available from NTIS, PC A04/MF A01.

The report gives results of a small pilot-scale evaluation of the E-SOx process, undertaken to obtain information needed to conduct a planned 5 MWe field pilot demonstration. The process uses an electrostatic precipitator (ESP) for combined sulfur dioxide (SO_2) removal and particulate collection. The concept of spray drying is introduced to the inlet and/or first section of the ESP in which electrical components are removed. Because of the many ESPs at coal-fired power plants, the process is well suited to retrofitting. Evaluation results indicate that a 50-60% SO_2 removal at a calcium/sulfur ratio of 1.2-1.4 can be obtained. Furthermore, this SO_2 reduction can be achieved without degrading the particulate emissions event though the process requires a reduction in the collecting surface of the ESP. The use of a temperature-controlled electrode precharger to compensate for collecting surface loss is also described.

40599 (PB–90-220815/XAB) **Pollution control for utility power generation, 1990-2020.** Princiotta, F.T. Environmental Protection Agency, Research Triangle Park, NC (USA). Air and Energy Engineering Research Lab. 27 Mar 1990. 26p. (EPA–600/D-90/025). Available from NTIS, PC A03/MF A01.

The paper discusses pollution control for utility power generation between the years 1990 and 2020, when the major anticipated environmental challenges facing the utility industry will be acid deposition control in the near term and global warming mitigation in the longer term. The President has proposed an ambitious acid rain control program requiring reduction of 10 million tons of sulfur dioxide (SO_2) by the year 2000. Options available to the utility industry include coal switching, flue gas desulfurization, and such

emerging lower cost technologies as Limestone Injection Multistage Burners (LIMB) and Advanced Silicate (ADVACATE), both developed by EPA. Since utility boilers, especially coal boilers, are major emitters of carbon dioxide (CO_2), they are candidates for mitigation to prevent unacceptable global warming. Utility options to deal with this problem include user conservation, increased use of nuclear power, renewable generators (biomass and solar), clean coal technologies, and increased use of natural gas. Model analysis suggests that in the 1990-2020 time frame conservation is critical. Non-fossil fuel technologies can also make significant contributions to reducing CO_2 emissions, but their role is limited by likely penetration in this time frame. Clean coal technologies (e.g., integrated coal gasification combined cycle) seem to provide only marginal CO_2 reduction benefits.

2005 Environmental Aspects

Refer also to citation(s) 40275

2006 Economic, Industrial, and Business Aspects

Refer also to citation(s) 40350, 40584, 40889

40600 (ANL/EAIS/TM–18) **STochastic Analysis of Technical Systems (STATS): A model for evaluating combined effects of multiple uncertainties.** Kranz, L. (Technische Hochschule Aachen (Germany, F.R.). Lehrstuhl und Inst. fuer Wirtschaftswissenschaften); VanKuiken, J.C.; Gillette, J.L.; Buehring, W.A. Argonne National Lab., IL (USA). Environmental Assessment and Information Sciences Div. Dec 1989. 65p. Sponsored by U.S. DOE Fossil Energy. DOE Contract W-31109-ENG-38. Order Number DE90013599. Available from NTIS, PC A04/MF A01 - OSTI; GPO Dep.

The STATS model, now modified to run on microcomputers, uses user- defined component uncertainties to calculate composite uncertainty distributions for systems or technologies. The program can be used to investigate uncertainties for a single technology on to compare two technologies. Although the term "technology" is used throughout the program screens, the program can accommodate very broad problem definitions. For example, electrical demand uncertainties, health risks associated with toxic material exposures, or traffic queuing delay times can be estimated. The terminology adopted in this version of STATS reflects the purpose of the earlier version, which was to aid in comparing advanced electrical generating technologies. A comparison of two clean coal technologies in two power plants is given as a case study illustration. 7 refs., 35 figs., 7 tabs.

40601 (ANL/EAIS/TM–19) **A user's guide to ICARUS: A model for Investigating Cost and Reliability in Utility Systems.** Guziel, K.A.; VanKuiken, J.C.; Buehring, W.A. Argonne National Lab., IL (USA). Environmental Assessment and Information Sciences Div. Feb 1990. 133p. Sponsored by U.S. DOE Fossil Energy. DOE Contract W-31109-ENG-38. Order Number DE90014705. Available from NTIS, PC A07/MF A01 - OSTI; GPO Dep.

ICARUS is an energy system planning tool for assessing the reliability and economic performance of alternative expansion patterns of electric utility generating systems. Input information includes capacity, forced outage rate, number of weeks of scheduled maintenance, and economic data for individual units, along with expected utility load characteristics. The model calculates (1) a system maintenance schedule, (2) the loss-of-load probability, (3) unserved demand for electrical energy, (4) required capacity reserve to meet a specified reliability criterion, (5) the effects of emergency interties, (6) expected energy generation and cost from each unit and block, (7) total generating system costs, and (8) fuel use. Firm purchases and sales of electricity can be included in the analysis. ICARUS uses a modified probabilistic simulation technique that produces an acceptable level of accuracy while significantly reducing computation requirements. It has been used to determine the replacement energy costs for short-term shutdowns, to calculate time-of-day tariffs that are based on short-run marginal cost of energy, and to show the effects of new technologies on system reliability. This report documents the personal computer version of the ICARUS model and provides guidance in preparing data input. 29 refs., 10 figs., 12 tabs.

40602 (IAEA-TECDOC–528, pp. 45-53) **Economic analysis of a power plant using WASP.** Chen Qiuxin (Beijing Economic Research Inst. of Water Resources and Electric Power, BJ (China)); Ge Zhengxiang. International Atomic Energy Agency, Vienna (Austria). Oct 1989. (CONF-8812139–: RCA workshop on the WASP/MAED coomputer programs, Kuala Lumour (Malaysia), 5-9 Dec 1988). In *Experience with WASP and MAED among IAEA Member States participating in the Regional Co-operative Agreement (RCA) in Asia and the Pacific Region: Proceedings of the RCA workshop on the WASP/MAED computer programs held in Kuala Lumpur, Malaysia 5-9 December 1988.* Order Number DE90634346. Available from NTIS (US Sales Only), PC A13/MF A01; OSTI; INIS.

Economic analysis on a power plant is a key activity in its feasibility study. This paper deals with the problems in this field faced by Chinese power system planners, and describes the experience in solving the problem. Particular emphasis is given in the paper to the evaluation of shadow prices to reflect the opportunity costs for the commodities needed for construction of power plants and their future operation. An attempt to evaluate these costs for some power plants is described in the paper. (author). 5 tabs.

21 NUCLEAR POWER PLANTS

Refer also to citation(s) 40784

40603 (IAEA-TECDOC–547) **The use of probabilistic safety assessment in the relicensing of nuclear power plants for extended lifetimes.** International Atomic Energy Agency, Vienna (Austria). Feb 1990. 78p. Order Number DE90634084. Available from NTIS (US Sales Only), PC A05/MF A01; OSTI; INIS.

This document gives guidance in the major ways PSAs can be used for NPP life extension applications utilizing given PSA criteria. It also covers the specific steps for using presently available PSA models, data and criteria to assist life extension decision making and the research that could be carried out to extend the applicability of PSAs in this field. Refs, figs and tabs.

40604 (NUREG–0020-Vol.14-No.3) **Licensed operating reactors: Status summary report data as of February 28, 1990: Volume 14, No. 3.** Hartfield, R.A. Nuclear Regulatory Commission, Washington, DC (USA). Div. of Computer and Telecommunications Services. Mar 1990. 498p. Sponsored by Nuclear Regulatory Commission. Available from NTIS, PC A21/MF A01 - GPO; OSTI; INIS.

The US Nuclear Regulatory Commission's monthly Licensed Operating Reactors Status Summary Report provides data on the operation of nuclear units as timely and accurately as possible. This information is collected by the Office of Information Resources Management, from the Headquarters Staff of NRC's Office of Inspection and Enforcement, from NRC's Regional Offices, and from utilities. This report is divided into three sections: the first contains monthly highlights and statistics for commercial operating units, and errata from previously reported data; the second is a compilation of detailed information on each unit, provided by NRC Regional Offices, IE Headquarters and the Utilities; and the third section is an appendix for miscellaneous information such as spent fuel storage capability, reactor years of experience and non-power reactors in the United States.

40605 (ORNL/FTR–3673) **[Expert Group on small and medium size reactors]: Foreign trip report, June 25, 1990–June 28, 1990.** Rowan, W.J. Oak Ridge National Lab., TN (USA). 13 Jul 1990. 4p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC05-84OR21400. Order Number DE90014412. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The traveler represented the US Department of Energy in a meeting of OECD's SMR Expert Group (June 25–28 1990). Topics addressed at the meeting were: (1) progress on the accomplishments of the group's study, (2) review of draft material for various sections of the group's summary report, (3) changes in the structure and content of the report, and (4) assignments and schedules to assure that the report will be issued on time.

2101 Power Reactors, Nonbreeding, Light-Water Moderated, Boiling Water Cooled

Refer also to citation(s) 40732, 40775, 40794, 40795, 40809, 40811, 40815, 40816, 40817, 40825, 40827

40606 (EPRI-NP–6899-D-Vol.1) **Inspection accessibility study of the Millstones Unit 1 Reactor Pressure Vessel: Volume 1, Accessibility study: Final report.** Calhoun, G. (Westinghouse Electric Corp., Pittsburgh, PA (USA)); Kapoor, A.; Davis, J.B. Electric Power Research Inst., Palo Alto, CA (USA); Westinghouse Electric Corp., Pittsburgh, PA (USA). ©Jul 1990. 98p. Sponsored by Electric Power Research Institute. Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

The need for more extensive ultrasonic examination of the Reactor Pressure Vessel (RPV) shell welds at some of the BWR plants is becoming apparent. Recent NRC comments regarding limits on future inspection relief requests and proposed revisions to the ASME Boiler and Pressure Vessel Code, Section 11 have caused BWR plant owners and vendors of inspection services to look at inspection tooling that would allow for the ultrasonic examination of RPV shell welds previously considered inaccessible. One approach to inspection of the RPV shell welds that will allow for greater coverage at some BWR plants is to perform these inspections from inside the vessel. In late 1988, Westinghouse received a contract from Northeast Utilities to examine the flange ligament areas and the shell welds in the upper portion of the Millstone Unit 1 PRV during an outage scheduled to begin in April 1989. This examination was performed with an inspection tool placed inside of the vessel and the UDRPS data acquisition system. The inspection tool was based on tooling used routinely at the Swedish and Finnish BWRs. The object of RP C105-1 was to use the information gathered prior to and during the Millstone Unit 1 examination and to perform an inspection accessibility study and prepare a report covering the lessons learned during the examination that would benefit other BWR utilities considering similar inspections. The final report consists of two volumes. This document, Volume 1, describes a 3D model of the Millstone Unit 1 PRV that was based on information obtained from plant drawings. The model is a useful tool for visualizing areas of limited access from both inside and outside of the RPV. 5 refs., 38 figs., 4 tabs.

40607 (EPRI-NP–6899-D-Vol.2) **Inspection accessibility study of the Millstone Unit 1 Reactor Pressure Vessel: Volume 2, Vessel inspection and lessons learned: Final report.** Davis, J.B. (Westinghouse Electric Corp., Pittsburgh, PA (USA)). Electric Power Research Inst., Palo Alto, CA (USA); Westinghouse Electric Corp., Pittsburgh, PA (USA). ©Jul 1990. 39p. Sponsored by Electric Power Research Institute. Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

The need for more extensive ultrasonic examination of the Reactor Pressure Vessel (RPV) shell welds at some of the BWR plants is becoming apparent. Recent NRC comments regarding limits on future inspection relief requests and proposed revisions to the ASME Boiler and Pressure Vessel Code, Section 11 have caused BWR plant owners and vendors of inspection services to look at inspection tooling that would allow for the ultrasonic examination of RPV shell welds previously considered inaccessible. One approach to inspection of the RPV shell welds that will allow for greater coverage at some BWR plants is to perform these inspections from inside the vessel. Such inside the vessel examinations are routinely performed in the BWRs in Sweden and Finland. In late 1988, Westinghouse received a contract from Northeast Utilities to examine the flange ligament areas and the shell welds in the upper portion of the Millstone Unit 1 RPV during an outage scheduled to begin in April 1989. This examination was performed with an inspection tool placed inside of the vessel and the UDRPS data acquisition system. The inspection tool was based on tooling used routinely at the Swedish and Finnish BWRs. The object of RP C105-1 was to use the information gathered prior to and during and prepare a report covering the lessons learned during the examination that would benefit other BWR utilities considering similar inspections. This document, Volume 2, describes the Millstone Unit 1 inspection and the lessons learned as a result. 9 figs.

40608 (JAERI-M–90-019) **UNITBURN: a computer code for burnup calculation of a unit fuel cell.** Naito, Yoshitaka (Japan Atomic Energy Research Inst., Tokai, Ibaraki (Japan). Tokai Research Establishment); Masukawa, Fumihiro; Inamura, Minoru; Okuda, Yasuhisa. Japan Atomic Energy Research Inst., Tokyo (Japan). Feb 1990. 65p. (In Japanese). Order Number DE90508050. Available from NTIS (US Sales Only), PC A04/MF A01.

A computer code UNITBURN has been developed for performing burnup calculation of a unit fuel cell. This code calculates neutron flux distribution in a cell by S_N-P_L method with Multi Group Constants Library (MGCL) and estimates buildup and depletion of nuclides in a fuel pellet. It also calculates nuclear few group constants averaged over a cell for calculation of fuel bundle or whole reactor core, and one group neutron cross sections at each burnup for nuclide generation and decay calculation code COMRAD. This report is a user's manual for UNITBURN. (author).

40609 Philadelphia Electric Company's computer replacement lessons learned at Peach Bottom. Clark, J.M.; O'Hara, J. *Transactions of the American Nuclear Society (USA),* 59: 291-292 (1989). (CONF-890604–: Annual meeting of the American Nuclear Society, Atlanta, GA (USA), 4-8 Jun 1989).

The current regulatory climate continues to prod today's nuclear utilities toward safer and more reliable operation of their plants. U.S. Nuclear Regulatory Commission guides NUREG-0660, NUREG-0696, and Supplement I to NUREG-0737 have all set forth increased requirements for plant monitoring. In response, the industry has looked at their existing plant computer systems as targets for enhancement or upgrade. This external pressure is nearly matched by the increasing demands made on existing computer systems by utility engineering and operations departments. The longer utilities postpone this evolution, the more likely they are to replace the entire system rather than upgrade the existing one. The older systems become harder to maintain and eventually are technically inferior to new systems, which have benefited from advances in computer technology in recent years. Enhancements become less economically advantageous than system replacements as the spread in technology widens. The object of this paper is to describe the Plant Process Computer Replacement Project at Philadelphia Electric Company's (PECo's) Peach Bottom Atomic Power Station. This paper explores (a) the impact on the plant, (b) the design and engineering services required, and (c) the planning and communication essential to a successful computer replacement project.

40610 Influence of high-worth control rods on burnable absorber design. Lindner, J.; Albertsson, M.; Johansson, L.E. *Transactions of the American Nuclear Society (USA),* 59: 314-315 (1989). (CONF-890604–: Annual meeting of the American Nuclear Society, Atlanta, GA (USA), 4-8 Jun 1989).

Two-dimensional studies have previously indicated the possibility of significant fuel cycle cost reduction in boiling water reactors (BWRs) equipped with ABB Atom high-worth control rods. These high-worth control rods have ~5 to 10% higher rod worth than standard control rods. This work summarizes the results of extensive three-dimensional analysis of the burnable absorber design for the German BWR/4,D-LATTICE reactor, KKB, equipped with ~50% high-worth ABB Atom control rods. This three-dimensional analysis confirms the earlier two-dimensional predictions. Furthermore, this paper illustrates the type of advantages that can be achieved the high-worth control rods by reducing the burnable absorber content.

40611 Verification of TGBLA methods on flux-trap-type hafnium control blades through critical experiments analyses. Ando, Yoshihira; Yamamoto, Munenari; Ueda, Makoto; Yoshioka, Ritsuo. *Transactions of the American Nuclear Society (USA),* 59: 316-317 (1989). (CONF-890604–: Annual meeting of the American Nuclear Society, Atlanta, GA (USA), 4-8 Jun 1989).

The development of long-lived control blades (CBs) is among the key factors for obtaining the maximum benefit from the control cell core (CCC) design concept, which has been applied in many operating boiling water reactors (BWRs) to improve performance in operation. The flux-trap-type all-hafnium CB has been recently proposed as a long-lived CB replacement in current BWRs by which problems inherent in hafnium poison, i.e., heavy weight and small

reactivity worth, were overcome. The nuclear life of this type of CB is estimated to be much longer than that of current B_4C CBs, so this CB may be best fit for the CCC design concept. A pair of hafnium plates are separated from each other by a water gap and inserted in a stainless steel sheath. The water gap between two hafnium plates is a so-called flux-trap region where neutrons transmitted in the plates are slowed down and absorbed on the inside surfaces of the plates (flux-trap effect). This effect compensates for the worth reduction resulting from thinning hafnium plates. A series of critical experiments were performed at Nippon Atomic Industry Group's Critical Assembly facility to investigate the reactivity properties of this type of CBs, including the fundamental flux-trap effect. Measurements were also performed to investigate the influence on fuel-rod power distribution due to changes in CB structure and poison material. These provided good benchmark data with which to verify the methods of the BWR lattice nuclear design code, TGBLA on the treatment of this type of CB.

40612 Experience in estimating neutron poison worths. Chiang, R.T.; Congdon, S.P. *Transactions of the American Nuclear Society (USA)*, 59: 317-318 (1989). (CONF-890604–: Annual meeting of the American Nuclear Society, Atlanta, GA (USA), 4-8 Jun 1989).

Gadolinia, ^{135}Xe, ^{149}Sm, control rod, and soluble boron are five neutron poisons that may appear in light water reactor assemblies. Reliable neutron poison worth estimation is useful for evaluating core operating strategies, fuel cycle economics, and reactor safety design. Based on physical presence, neutron poisons can be divided into two categories: local poisons and global poisons. Gadolinia and control rod are local poisons, and ^{135}Xe, ^{149}Sm, and soluble boron are global poisons. The first-order perturbation method is commonly used to estimate nuclide worths in fuel assemblies. It is well known, however, that the first-order perturbation method was developed for small perturbations, such as the perturbation due to weak absorbers, and that neutron poisons are not weak absorbers. The authors have developed an improved method to replace the first-order perturbation method, which yields very poor results, for estimating local poison worths. It has also been shown that the first-order perturbation method seems adequate to estimate worths for global poisons caused by flux compensation.

2102 Power Reactors, Nonbreeding, Light-Water Moderated, Nonboiling Water Cooled

Refer also to citation(s) 40607, 40608, 40612, 40699, 40704, 40730, 40732, 40733, 40775, 40781, 40782, 40786, 40787, 40789, 40790, 40794, 40795, 40800, 40801, 40807, 40808, 40809, 40811, 40813, 40816, 40817, 40820, 40821, 40823, 40824, 40825, 40827, 40882, 41285

40613 (CEA-CONF–9993) **Design rules for piping: Plastic stability of straight parts under level D loadings.** Touboul, F.; Ben Djidia, M.; Acker, D. CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Dept. d'Etudes Mecaniques et Thermiques. 1989. 6p. (CONF-890855–: 10. international conference on Structural Mechanics in Reactor Technology (SMIRT), Anaheim, CA (USA), 14-18 Aug 1989). Order Number DE90508367. Available from NTIS (US Sales Only), PC A02/MF A01.

Design rules for piping, elaborated for Fast Breeder Reactors, are based on analysis performed for Pressure Water Reactors. Interpretation of largely diversified straight parts tests, enable us to validate and improve existing rules and to propose a more suitable formula. Design rules for piping appear to be non conservative for austenitic thin tubes in bending or torsion. By introducing a B_2 coefficient, geometrically dependent, the gap between thin and thick tubes may be withheld. Conservatism of rules can be ensured by considering the allowable stress defined by ASME, Section III, Appendix F.

40614 (CEA-CONF–9994) **Hydro mechanical analysis of a primary pipe (1D) coupled to a reactor vessel (3D) during a depressurisation.** Schwab, B.; Lepareux, M.; Combescure, A.; Makil, H. CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Dept. d'Etudes Mecaniques et Thermiques. 1989. 10p. (CONF-890855–: 10. international conference on Structural Mechanics in Reactor Technology (SMIRT), Anaheim, CA (USA), 14-18 Aug 1989). Order Number DE90508368. Available from NTIS (US Sales Only), PC A02/MF A01.

It is possible to analyse separately, in 3D, the transitory hydromechanical regimes of the vessel and the pipe respectively. However, the treatment of fluid-structure coupling at the junction, demands the modelisation of the complete system. This paper presents some validation tests and the results of PWR blowdown calculation.

40615 (CEA-CONF–9997) **Experimental evaluation of J in cracked straight and curved pipes under bending.** Moulin, D.; Touboul, F.; Foucher, N.; Lebey, J.; Acker, D. CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Dept. d'Etudes Mecaniques et Thermiques. 1989. 4p. (CONF-890855–: 10. international conference on Structural Mechanics in Reactor Technology (SMIRT), Anaheim, CA (USA), 14-18 Aug 1989). Order Number DE90508399. Available from NTIS (US Sales Only), PC A02/MF A01.

An experimental program is being carried out at the CEA Saclay in collaboration with FRAMATOME and IPSN with a view to validate analysis methods applicable for evaluation of leak before break behavior in P.W.R. piping. A large experimental work was already performed in USA, Germany and Japan and cracked pipes made of stainless steel material under bending. The methods of analysis got same validations for straight pipes. However applicability to elbows and comparison with toughness values obtained on small specimens like CT specimens was not completely dealt with.

40616 (CEA-CONF–9999) **A finite element method for SSI time history calculations.** Ni, X.M.; Gantenbein, F.; Petit, M. CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Dept. d'Etudes Mecaniques et Thermiques. 1989. 6p. (CONF-890855–: 10. international conference on Structural Mechanics in Reactor Technology (SMIRT), Anaheim, CA (USA), 14-18 Aug 1989). Order Number DE90508404. Available from NTIS (US Sales Only), PC A02/MF A01.

The method which is proposed is based on a finite element modelisation for the soil and the structure and a time history calculation. It has been developed for plane and axisymmetric geometries. The principle of this method will be presented, then applications will be given, first to a linear calculation for which results will be compared to those obtained by standard methods. Then results for a non linear behavior will be described.

40617 (NIS–985) **Reduction of americium quantity by recycling in large PWR type reactors. Final report.** Eiselt, G.; Keck, B. Nuklear-Ingenieur Service GmbH, Hanau (Germany, F.R.); Bundesministerium fuer Forschung und Technologie, Bonn (Germany, F.R.). Dec 1988. 157p. (In German). Contract BMFT 315-5691-KWA-16020. Available from Nuklear-Ingenieur Service GmbH, Hanau (Germany, F.R.).

Contains 1st interim report (NIS–867) and 2nd interim report (NIS–933).

It was investigated to what extent the quantities of Am (Am-241) resulting from the β decay of Pu-241 can be reduced by means of an appropriate feedback into large PWR (1300 MWe) after reprocessing and temporary storage in order to keep the quantity of Am which has to be finally stored as small as possible. The transmutation behaviour of the Am-241 in the thermal neutron field was studied in detail, and the relevant nuclide chains and the activation cross-sections were included into the program CASMO. By means of this - a modern two-dimensional transport/burnup program - all necessary parameter analyses were carried out, and a possible fuel element containing Am for the PWR of the Biblis type was designed. Furthermore it was studied how such fuel elements had to be handled, how they could be used in the reactor, and what consequences arise for the fuel element production and the final storage of the resulting nuclear waste. (HP).

40618 (NUREG/CR–5117) **Steam Generator Tube Integrity Program/Steam Generator Group Project: Final project summary report.** Kurtz, R.J. (Pacific Northwest Lab., Richland, WA (USA)); Clark, R.A.; Bradley, E.R.; Bowen, W.M.; Doctor, P.G.; Ferris, R.H.; Simonen, F.A. Nuclear Regulatory Commission,

Washington, DC (USA). Div. of Engineering; Pacific Northwest Lab., Richland, WA (USA). May 1990. 205p. Sponsored by Nuclear Regulatory Commission. DOE Contract AC06-76RL01830. Available from NTIS, PC A10/MF A01 - GPO; OSTI; INIS.

The Steam Generator Tube Integrity Program/Steam Generator Group Project was a three-phase program conducted for the US Nuclear Regulatory Commission (NRC) by Pacific Northwest Laboratory. The main goal of the program was to provide the NRC with validated information on the reliability of nondestructive examination techniques to defects and size flaws in steam generator tubing and to determine the remaining integrity of service-degraded tubing. This report summarizes the findings of more than eleven years of research activity on steam generator tube integrity and inspection issues. The results of the Phase 1 pressure tests on mechanically-flawed steam generator tubing are presented. In addition, the laboratory eddy current (EC) sizing results on those tubes are summarized. A discussion of Phase 2 pressure test results on chemically-degraded tubes is given, along with a brief overview of leak-rate data for tubes with laboratory-produced axial or circumferential stress-corrosion cracks (SCC). Comparisons with a simple analytical leak rate model are discussed. Laboratory EC estimates of flaw size in Phase 2 specimens are described. To supplement the laboratory EC data and obtain an estimate of EC reliability to detect and size SCC, results of a mini-round robin involving several firms that routinely perform field inservice inspections are presented.

40619 (NUREG/CR–5556) **Review of current literature related to Generic Safety Issue 15.** Lipinski, R.E.; Garner, R.W. Nuclear Regulatory Commission, Washington, DC (USA). Div. of Safety Issue Resolution; EG and G Idaho, Inc., Idaho Falls, ID (USA). Jul 1990. 18p. Sponsored by Nuclear Regulatory Commission. DOE Contract AC07-76ID01570. (EGG–2598). Available from NTIS, PC A03/MF A01 - GPO; OSTI; INIS.

Recent evaluations of surveillance samples in the High Flux Isotope Reactor at the Oak Ridge National Laboratory led to the conclusion that the embrittlement rates of several reactor pressure vessel (RPV) steels may be greater than originally anticipated. In June 1987, the Advisory Committee on Reactor Safeguards requested that the US Nuclear Regulatory Commission investigate the consequences of embrittlement of RPV supports. This report summarizes the current literature related to these studies, evaluates their contribution toward resolving Generic Safety Issues 15 concerning material embrittlement, and recommends any further action considered appropriate. This review also contains a short discussion of the uses of structural mechanics and fracture mechanics to analyze embrittlement. 15 refs., 1 fig., 3 tabs.

40620 (ORNL/FTR–3662) **[Reactor vessel embrittlement]: Foreign trip report, June 21–30, 1990.** Cheverton, R.D. Oak Ridge National Lab., TN (USA). 16 Jul 1990. 36p. Sponsored by Nuclear Regulatory Commission. DOE Contract AC05-84OR21400. Order Number DE90014301. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The scope of the exchange meeting included US and USSR presentations regarding (1) annealing of reactor vessels (the USSR has annealed nine vessels thus far), (2) research on reactor-vessel materials from reactors taken out of service (Shippingport Gundremmingen, and Novovoronezh), (3) radiation embrittlement of materials for the vessel in VVER-1000 type reactors, (4) application of embrittlement data to operating reactors, (5) mechanisms of radiation damage to vessel materials, and (6) pressurized-thermal-shock issues, including a comparison of US and USSR calculated values of the conditional probability of vessel failure. The traveler was primarily concerned with item 6. The USSR revealed that they evaluate vessel integrity using a deterministic approach for which the design-basis transients are defined with the aid of event trees. These transients are less severe than the most severe transient considered in the US Integrated Pressurized-Thermal-Shock (IPTS) analysis, but the USSR believes their approach is more conservative because the most severe US transients have a very low anticipated frequency of occurrence. The USSR is considering a probabilistic approach to the evaluation of vessel integrity and have compared their results with ours. Differences exist and the reasons for the differences were identified.

40621 (ORNL/FTR–3667) **[Reactor materials embrittlement]: Foreign trip report, June 21, 1990–June 30, 1990.** Nanstad, R.K. Oak Ridge National Lab., TN (USA). 13 Jul 1990. 32p. Sponsored by Nuclear Regulatory Commission. DOE Contract AC05-84OR21400. Order Number DE90014311. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The traveler served as a member of a delegation from the US Nuclear Regulatory Commission in an information exchange meeting on nuclear safety with the USSR in Moscow, USSR, June 25–29, 1990. The meetings were held within the framework of the US-USSR Joint Coordinating Committee on Civilian Nuclear Reactor Safety. The traveler participated in the meetings of Working Group 3 on Radiation Embrittlement of the Housing (Pressure Vessel) and Support Structures, and Annealing of the Housing. This was the second meeting for Working Group 3; the first was held in Washington, D.C., in June 1989 and the traveler has participated in both. The traveler presented results of research on the effects of irradiation on crack-arrest toughness of submerged-arc welds, fracture toughness of stainless steel cladding, and mechanisms of radiation embrittlement in pressure vessel steels. The meetings resulted in detailed exchange of technical progress between participants, identification of specific areas requiring continued research, agreements regarding exchange of additional information, agreements on exchange of reactor vessel materials, and US witnessing of a thermal annealing of a USSR-designed commercial light-water reactor vessel.

40622 Experimental and analytical qualification of elastomeric seals in nuclear power stations. Yaksh, M.C. *Transactions of the American Nuclear Society (USA)*, 59: 285-287 (1989). (CONF-890604–: Annual meeting of the American Nuclear Society, Atlanta, GA (USA), 4-8 Jun 1989).

During refueling of the pressurized water reactor type of nuclear power stations, the cavity surrounding the top of the reactor is filled with water to maintain acceptable levels of radiation while fuel is being transferred from the reactor. A generic illustration of this type of seal is shown which was a commonly used pneumatic seal. This particular seal has continued to receive some attention since I&E Bulletin 84-03 was issued. While most plants addressed this issue at some time in the past, some plants continue to address concerns about other types of seals located in the plant. At the time of the I&E Bulletin 84-03, other elastomeric-type seals were examined at meetings such as those held under the auspices of the Institute of Nuclear Power Operations. This paper addresses the testing performed on the seal used in refueling as well as the analytical method employed to accomplish the same purpose.

40623 SAMO [Sistema de Apoyo Mechanizado a la Operacion]: An operational aids computer system. Stormer, T.D.; Laflor, E.V. *Transactions of the American Nuclear Society (USA)*, 59: 287-288 (1989). (CONF-890604–: Annual meeting of the American Nuclear Society, Atlanta, GA (USA), 4-8 Jun 1989).

SAMO (Sistema de Apoyo Mechanizado a la Operacion) is a sensor-driven, computer-based, graphic display system designed by Westinghouse to aid the A. N. Asco operations staff during all modes of plant operations, including emergencies. The SAMO system is being implemented in the A. N. Asco plant in two phases that coincide with consecutive refueling outages for each of two nuclear units at the Asco site. Phase 1 of the SAMO system implements the following functions: (1) emergency operational aids, (2) postaccident monitoring, (3) plant graphics display, (4) high-speed transient analysis recording, (5) historical data collection, storage, and retrieval, (6) sequence of events, and (7) posttrip review. During phase 2 of the SAMO project, the current plant computer will be removed and the functions now performed by the plant computer will be performed by the SAMO system. In addition, the following functions will be implemented: (1) normal and simple transients operational aid, (2) plant information graphics; and (3) real-time radiological off-site dose calculation.

40624 Improved outage management techniques for better plant availability. Bemer, J.P. *Transactions of the American Nuclear Society (USA)*, 59: 288-289 (1989). (CONF-890604–: Annual meeting of the American Nuclear Society, Atlanta, GA (USA), 4-8 Jun 1989).

To maintain high availability of nuclear generating units is one of the most important management objectives. The duration of outages-whether planned or unplanned-is the main parameter impacting on plant availability, but the planned outages, and essentially the refueling outages, are the most important in this respect, and they also have a heavy impact on the economics of plant operation. The following factors influence the duration of the outages: (1) modifications; (2) preventive maintenance operations; and (3) corrective maintenance operations of generic faults. In this paper, the authors examine how the outage management organization of Electricite de France (EdF) plants is tending to optimize the solutions to the above-mentioned points.

40625 Load-follow control simulation with optimization. Yim, Man-Sung; Christenson, J.M. *Transactions of the American Nuclear Society (USA),* 59: 289-290 (1989). (CONF-890604--: Annual meeting of the American Nuclear Society, Atlanta, GA (USA), 4-8 Jun 1989).

For the simulation of load-follow control operation of pressurized water reactors (PWRs), the system model needs to describe both primary and secondary system behaviors, because the load-change signal in the secondary system delivers a change in the primary system through the thermal-hydraulic interactions in the steam generator. In this study, the characteristics of load-follow control for a PWR were investigated using a one-dimensional core model combined with a simplified nuclear steam supply system model using optimization. The overall system model includes one-dimensional core neutronics with all the space-dependent feedback effects, Xe-I dynamics, core thermal balances, primary loop thermal balances, and steam generator dynamic responses to turbine load changes. The final system equations were manipulated for the lumped parameter representations by using the model expansion technique for the core model.

40626 Expanded bases for technical specifications appropriate to Westinghouse pressurized water reactors. Daschke, K.D.; Smith, G.G. *Transactions of the American Nuclear Society (USA),* 59: 294-295 (1989). (CONF-890604--: Annual meeting of the American Nuclear Society, Atlanta, GA (USA), 4-8 Jun 1989).

In June 1986 the Westinghouse Owners' Group (WOG) authorized the initiation of a phased program to improve the technical specifications applicable to Westinghouse pressurized water reactors. By March 31, 1989, the WOG will submit phase 2 of this program to the U.S. Nuclear Regulatory Commission (NRC) for review. Phase 2 will include the creation of a new and Expanded Bases for each specification retained in the WOG's new restructured technical specifications. The intent of the Expanded Bases is to provide the following for each technical specification: (1) complete background, including an explanation of each restructured technical specification parameter or component requirement, and surveillance requirement; (2) broader utility input to content of the Bases; (3) established licensing baseline for future specification changes; (4) improved consistency of utility, vendor, and NRC interpretations; and (5) improved operator training.

40627 Fuel rod clip program at Duke Power's McGuire nuclear stations. Tomonto, R.J.; Reparaz, A. *Transactions of the American Nuclear Society (USA),* 59: 285 (1989). (CONF-890604--: Annual meeting of the American Nuclear Society, Atlanta, GA (USA), 4-8 Jun 1989).

During the Duke Power Company McGuire-1 end-of-Cycle-3 refueling outage, debris, including loose fuel pellets, were found. Duke Power determined that the debris resulted from three failed fuel rods from one peripheral assembly. The cladding of these three fuel rods had failed due to fretting resulting from baffle jetting. Prevention of further baffle-jetting damage was essential to forestall increased reactor and coolant contamination, maintain fuel assembly integrity, and minimize the impact on core operating power. Duke Power performed a study of possible methods of modifying a fuel assembly to eliminate baffle-jetting damage. The most promising approach was the proven fuel-rod clips designed by Advanced Nuclear Fuels Corporation (ANF) on assemblies exposed to baffle jetting. Installation of ANF fuel-rod clips in the McGuire-1 and McGuire-2 reactors by Duke Power has proven successful in eliminating baffle-jetting damage. Both reactors have operated one full cycle with ANF clips. No more baffle-jetting failures have been reported. Clip removal at the end of the cycle was carried out on schedule. Estimation of the clip removal force indicated the clips were firmly attached to the rods, thus confirming the adequacy of the clip design. Both reactors are now in their second cycle of operation with ANF clips.

40628 The Prairie Island configuration management program plan. Maxey, T.M.; Rolfson, G.A. *Transactions of the American Nuclear Society (USA),* 59: 301-303 (1989). (CONF-890604--: Annual meeting of the American Nuclear Society, Atlanta, GA (USA), 4-8 Jun 1989).

The Prairie Island Nuclear Generating Plant completed the development of its Configuration Management Program Plan in late 1988. The purpose of the plan was to establish the philosophies and perspectives of configuration management (CM) that will be used to guide the formal implementation of the CM program. In addition, a series of specific activities was defined to build on currently successful programs at Prairie Island and further the implementation of CM. This paper discusses the role that plant operations, training, and maintenance play in CM at Prairie Island.

40629 Evaluating plant modifications against industry operating experience. Swisshelm, J.D.; Riley, J.H.; Pabst, L.F. *Transactions of the American Nuclear Society (USA),* 59: 305 (1989). (CONF-890604--: Annual meeting of the American Nuclear Society, Atlanta, GA (USA), 4-8 Jun 1989).

To avoid repeating problems of the past, the U.S. Nuclear Regulatory Commission (NRC) excepts nuclear utilities to examine previous industry experience when considering plant design changes and modifications. Many systems have been proposed for categorizing previous industry experience, with emphasis on root cause analysis. If the root causes of previous industry events or problems were standardized, they would be useful in warning other plants of similar or related problems. It is difficult, however, to standardize root cause analysis methods and terminology in a way that makes experience data easily applied across different plants. In addition, identifying a root cause of a previous event only goes halfway in answering concerns about a plant modification. The modification must also be evaluated to determine if the root cause is of concern. This paper presents a unique solution to these problems by using an interdisciplinary approach to developing industry-standard root causes and by using expert system terminology to evaluate a plant modification against these root causes.

40630 Analysis of the use of flux suppression fixtures for Indian Point unit 3, cycle 7, and future cycles. Powers, M.A.; Ray, J.H. *Transactions of the American Nuclear Society (USA),* 59: 315-316 (1989). (CONF-890604--: Annual meeting of the American Nuclear Society, Atlanta, GA (USA), 4-8 Jun 1989).

The CASMO-2E and MBS programs have been used to obtain a qualitative evaluation of several means of reducing the fast neutron flux incident on the reactor vessel and thus increasing its useful life. A more detailed calculation using the DOT program will be performed to provide a quantitative evaluation at New York Power Authority (NYPA). The work described in this paper examined the effect of introducing different neutron absorbers into the assemblies closet to the reactor vessel. These are the eight twice-burned assemblies located in the northeast, northwest, southeast, and southwest corners of the reactor core. The absorbers considered were Ag-In-Cd (20 rods per assembly), hafnium (20 rods per assembly), stainless steel (20 rods per assembly), fresh wet annular burnable absorbers (WABA) (20 and 16 rods per assembly). These corner assemblies each have an average exposure just over 30 MWd/kg U so that the CASMO-2E depletion calculations with the absorbers inserted were started at 30 MWd/kg U.

40631 Implementation of thermal-hydraulic feedback in GR-PDQ. Justis, P.G. Jr. (Union Electric, St. Louis, MO (USA)); Smith, G.W. *Transactions of the American Nuclear Society (USA),* 59: 319-320 (1989). (CONF-890604--: Annual meeting of the American Nuclear Society, Atlanta, GA (USA), 4-8 Jun 1989).

A common deficiency exhibited in many conventional PDQ reactor core models is the lack of thermal-hydraulic feedback (THF). Numerous reasons exist for not including THF in hot, full-power PDQ models, and most of these focus on the complexity of using

the standard three-dimensional THF option in PDQ7V2, as well as its predecessors. The recently developed computer code GRPDQ greatly simplifies the incorporation of THF in PDQ models. GRPDQ, which is an enhanced version of PDQ7V2, simplifies the implementation of THF through a two-dimensional methodology that includes such features as multiple G factors, two-dimensional fuel temperature rise tables, and significantly reduced processing time, as well as numerous other enhancements. These features allow the user to take advantage of the benefits of modeling THF, while minimizing or eliminating such complexities as three-dimensional input representations and fuel and gap conductance input.

40632 An interface net current technique using polynomial-expanded nodal fluxes. Moon, H.; Levine, S.H. *Transactions of the American Nuclear Society (USA),* 59: 350-351 (1989). (CONF-890604--: Annual meeting of the American Nuclear Society, Atlanta, GA (USA), 4-8 Jun 1989).

Modern nodal methods for the calculation of reactor power distributions based on one of the higher order interface techniques, i.e., the interface partial current method, the interface net current method, and the interface flux method, have demonstrated a high level of accuracy and computational efficiency. By further improving the computational efficiency, it will be possible to apply this advanced numerical technique to a real-time three-dimensional simulation or to a multi-dimensional fuel management optimization calculation. The derivation of this new nodal method, the polynomial interface net-current technique (PINT), is straightforward and no ambiguous approximation is used. The solution process is similar to the line relaxation method used in the conventional finite difference method. For the three-dimensional problem, it is necessary to alternate the sequence of radial sweeping from one axial plane to another to have no preferred direction. The authors have tested this model for several benchmark problems and a fast convergence has always been achieved. The results from the International Atomic Energy Agency (IAEA) three-dimensional pressurized water reactor (PWR) problem are presented together with the results from several other published methods. For this result, PINT used the fourth-order expansion (l=4) and the quadratic transverse leakage approximation. This comparison clearly demonstrates the accuracy and the computing speed of the new method.

40633 A two-dimensional fuel loading optimization method for the pressurized water reactor burnup cycle. Stillman, J.A.; Chao, Y.A.; Downar, T.J. *Transactions of the American Nuclear Society (USA),* 59: 351-353 (1989). (CONF-890604--: Annual meeting of the American Nuclear Society, Atlanta, GA (USA), 4-8 Jun 1989).

A method was developed and reported earlier that determines the optimum fuel and power distributions for a pressurized water reactor (PWR) burnup cycle. The backward diffusion calculation and the corewise Green's function method were used for the core model, which provided analytic derivatives for solving the nonlinear optimization problem using successive linear programming methods. The solution algorithm consisted of a reverse depletion strategy that begins at the end of cycle and solves simultaneously for the optimal fuel and burnable absorber distributions while the core is depleted to the beginning of cycle. These distributions were constrained by a maximum fuel power peaking and by the fuel and burnable absorber depletion characteristics. Additionally, the problem was formulated to consider specific numbers of feed and discharge assemblies by including penalty terms in the objective function. The resulting optimal solutions were shown to minimize the required fissile fuel inventory and burnable absorber lading for several PWR examples. Previously reported solutions were not required to meet some specified fuel batch size; therefore, the optimal solutions did not represent practical PWR problems. The purpose of the work reported in this paper is to investigate the effect of imposing batch size constraints on the optimization problem. Specifically, results are presented here for the case of a core consisting of three equal-sized fuel batches in which an equilibrium condition is imposed on the batch average burnups.

40634 Field measurement of the piping system vibration of Ko-Ri unit 4 during the load-following operation. Chung, Tae-Young; Hong, Sung-Yull; Kim, Bum-Nyun. *Transactions of the American Nuclear Society (USA),* 59: 311-312 (1989). (CONF-890604--: Annual meeting of the American Nuclear Society, Atlanta, GA (USA), 4-8 Jun 1989).

During the load-following operation of nuclear power plants, flow rate, temperature, and pressure in the piping system can be varied by changing the electric power output level, and these variations can cause different vibration phenomena in the piping system. The piping system vibration is important because it is directly related to the dynamic stress of the piping system and can affect the life of the piping system through structural fatigue. An assessment of vibration levels for the classes II and III piping systems of the Ko-Ri Unit 4950-MW nuclear power plant was performed according to the given pattern of the load-following operation to study its feasibility from the viewpoint of piping system vibration. The classes II and III piping system vibration of the Ko-Ri Unit 4 may not cause any potential problem under the given pattern of the load-following operation; however, it is recommended that long-term operation in the 85 to 95% power range be avoided as much as possible.

2103 Power Reactors, Nonbreeding, Graphite Moderated

Refer also to citation(s) 40776, 40785, 40809

40635 (IWGGCR-20-1) **Eighth meeting of the International Working Group on Gas-Cooled Reactors, Vienna, 30 January - 1 February 1989. Summary report. Part 1.** International Atomic Energy Agency, Vienna (Austria). International Working Group on Gas-Cooled Reactors. Dec 1989. 23p. (CONF-8901194--: 8. meeting of the international working group on gas-cooled reactors, Vienna (Austria), 30 Jan 1989). Order Number DE90634103. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The Eighth Meeting of the IAEA International Working Group on Gas-Cooled Reactors was held in Vienna, Austria, from 30 January - 1 February, 1989. The Summary Report (Part I) contains the Minutes of the Meeting.

40636 (IWGGCR-20-2) **Eighth meeting of the International Working Group on Gas-Cooled Reactors Vienna, 30 January - 1 February 1989. Summary report. Part 2.** International Atomic Energy Agency, Vienna (Austria). International Working Group on Gas-Cooled Reactors. Dec 1989. 35p. (CONF-8901194--: 8. meeting of the international working group on gas-cooled reactors, Vienna (Austria), 30 Jan 1989). Order Number DE90634104. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The Eighth Meeting of the IAEA International Working Group on Gas-Cooled Reactors was held in Vienna, Austria, from 30 January - 1 February, 1989. The Summary Report (Part II) contains the papers which review the national programmes in the field of Gas-Cooled Reactors and other presentations at the Meeting. Refs, figs and tabs.

40637 (IWGGCR-20-2, pp. 33) **The CEC activities on gas cooled reactors.** Vivante, C. (Commission of the European Communities, Brussels (Belgium)). International Atomic Energy Agency, Vienna (Austria). International Working Group on Gas-Cooled Reactors. Dec 1989. (CONF-8901194--: 8. meeting of the international working group on gas-cooled reactors, Vienna (Austria), 30 Jan 1989). In *Eighth meeting of the International Working Group on Gas-Cooled Reactors Vienna, 30 January - 1 February 1989. Summary report. Part 2.* Order Number DE90634104. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Short communication. EUROPEAN COMMUNITIES/htgr type reactors; HTGR TYPE REACTORS/research programs; REACTOR SAFETY

40638 (IWGGCR-20-2, pp. 7-8) **HTR research and development in Austria - 1987-1988 progress report.** Proksch, E. (Oesterreichisches Forschungszentrum Seibersdorf G.m.b.H. (Austria)); Neumann, W. International Atomic Energy Agency, Vienna (Austria). International Working Group on Gas-Cooled Reactors. Dec 1989. (CONF-8901194--: 8. meeting of the international working group on gas-cooled reactors, Vienna (Austria), 30 Jan 1989). In *Eighth meeting of the International Working Group on Gas-Cooled Reactors Vienna, 30 January - 1 February 1989. Summary*

report. Part 2. Order Number DE90634104. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

This report summarizes R and D work on high-temperature reactor fuels, and high-temperature structural materials, which was performed in Austria since the 7th meeting of the International Working Group on Gas-Cooled Reactors of the IAEA. (author). 1 ref.

40639 (IWGGCR–20-2, pp. 8-9) **Progress of independent feasibility study for modular HTGR demonstration plant to be built in China.** He Jiachen (China National Nuclear Corp., Beijing (China). Nuclear Power Dept.). International Atomic Energy Agency, Vienna (Austria). International Working Group on Gas-Cooled Reactors. Dec 1989. (CONF-8901194–: 8. meeting of the international working group on gas-cooled reactors, Vienna (Austria), 30 Jan 1989). In *Eighth meeting of the International Working Group on Gas-Cooled Reactors Vienna, 30 January - 1 February 1989. Summary report. Part 2.* Order Number DE90634104. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Many regions in China are suffering from shortage of energy as a result of the rapid growth of the national economy, for example, the growth rate of national production in 1988 reached 11.2%. A great number of coal fired plants have been built in many industrial areas. However, the difficulties relating to the transportation of coal and environmental pollution have become more and more serious. The construction of hydropower plants is limited due to uneven geographic conditions and seasons. For these reasons China needs to develop nuclear power plants. Nowadays, it has been decided, that PWR will be the main reactor type in our country, but in some districts or under some conditions modular HTGR may have distinct advantages and become an attractive option. The possible plant site description and preliminary result of economic analysis of modular HTGR type reactor are briefly discussed in this presentation.

40640 (IWGGCR–20-2, pp. 10-11) **Present status of research on and development of HTGR techniques in the People's Republic of China.** Zhu Yongjun (Tsinghua Univ., Beijing, BJ (China). Inst. of Nuclear Energy Technology). International Atomic Energy Agency, Vienna (Austria). International Working Group on Gas-Cooled Reactors. Dec 1989. (CONF-8901194–: 8. meeting of the international working group on gas-cooled reactors, Vienna (Austria), 30 Jan 1989). In *Eighth meeting of the International Working Group on Gas-Cooled Reactors Vienna, 30 January - 1 February 1989. Summary report. Part 2.* Order Number DE90634104. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

China is a developing country rich in coal, petroleum and hydropower resources. In the past ten years, energy production in China has had a large increase, but along with the development of economy, energy demands increase even more rapidly. Many problems exist in China's energy system. Considering the large energy demand in the near future and long-term energy strategy, China has already decided to develop nuclear power gradually. The first several nuclear power stations are being and will be built in the South-east sea shore region. Two 900 MW PWRs (from France) and one 300 MW PWR (home made) are now under construction at Daya Bay (Kwangton Province) and Qin Shan (Zhejiang Province). The succeeding PWR power plants are being planned. PWR nuclear power station has been selected for the beginning of China's nuclear power plan. For large scale utilization of nuclear power in the next century, the development of advanced reactor type with good safety and economy performances and high uranium utilization rate (uranium resources in China is not rich enough) is strategically important. HTGR, due to its inherent safety characteristics, high heat efficiency, flexible fuel system and wide application fields, is a prospective advanced reactor type. Research and development on HTGR have already been included in China's national technical development program and are going on smoothly.

40641 (IWGGCR–20-2, pp. 12-13) **The gas cooled reactors in France in 1987 and 1988.** Bastien, D. (CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Div. d'Etude et de Developpement des Reacteurs). International Atomic Energy Agency, Vienna (Austria). International Working Group on Gas-Cooled Reactors. Dec 1989. (In French). (CONF-8901194–: 8. meeting of the international working group on gas-cooled reactors, Vienna (Austria), 30 Jan 1989). In *Eighth meeting of the International Working Group on Gas-Cooled Reactors Vienna, 30 January - 1 February 1989. Summary report. Part 2.* Order Number DE90634104. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The paper gives information concerning the operation of French gas cooled reactors Chinon A2, Chinon A3, St-Laurent A1, St-Laurent A2, and Bugey 1 in 1987 and 1988.

40642 (IWGGCR–20-2, pp. 17-20) **Status of the HTTR project in Japan.** Sanokawa, K. (Japan Atomic Energy Research Inst., Tokai, Naka, Ibaraki (Japan). Dept. of Power Reactor Projects). International Atomic Energy Agency, Vienna (Austria). International Working Group on Gas-Cooled Reactors. Dec 1989. (CONF-8901194–: 8. meeting of the international working group on gas-cooled reactors, Vienna (Austria), 30 Jan 1989). In *Eighth meeting of the International Working Group on Gas-Cooled Reactors Vienna, 30 January - 1 February 1989. Summary report. Part 2.* Order Number DE90634104. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

In June 1987, the Japanese Atomic Energy Commission issued the revision of the Long-Term Program for Development and Utilization of Nuclear Energy, recommending that Japan should proceed with the development of more advanced new technologies for the future, parallel to the existing nuclear systems. It also emphasizes that the HTGR is one of the most promising reactors with high efficiency and inherent safety, therefore it should be explored for the broader use of nuclear energy, not only for power production. Then the early construction of a High-Temperature engineering Test Reactor (HTTR) by JAERI was proposed. Based on this program, JAERI has changed the "VHTR program" for "HTTR program" to establish the HTGR technology basis and upgrade them. The permission of the HTTR construction was made by the Science and Technology Agency (STA) in February 1989. 3 figs, 2 tabs.

40643 (IWGGCR–20-2, pp. 20-23) **HTGR development in Switzerland - Progress report 1988.** Brogli, R. (Paul Scherrer Inst. (PSI), Villigen (Switzerland)). International Atomic Energy Agency, Vienna (Austria). International Working Group on Gas-Cooled Reactors. Dec 1989. (CONF-8901194–: 8. meeting of the international working group on gas-cooled reactors, Vienna (Austria), 30 Jan 1989). In *Eighth meeting of the International Working Group on Gas-Cooled Reactors Vienna, 30 January - 1 February 1989. Summary report. Part 2.* Order Number DE90634104. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Work in the field of HTGR development is performed in Switzerland by 5 industrial companies and by the Paul Scherrer Institute (PSI, formerly the Federal Institute of Reactor Technology), linked together in the IGNT (Swiss Interest Group for the development of Nuclear Technologies) within the framework of the German HTR-500 project, the aim of which is to prepare a bid for a 550 MWe HTGR power station within 4 to 5 years. An order for the first part of the planning phase of this plant has already been placed by German utilities. A group of Swiss utilities has decided to participate in the project. Another project which has been pursued in Switzerland in recent years is the GHR; a small pebble-bed HTGR for district-heating purposes. In 1988, work for this project has been limited for political reasons. The activities of the partners of the IGNT, performed mainly in the context of the HTR-500 project, are summarised in this presentation.

40644 (IWGGCR–20-2, pp. 24-30) **Status of work on gas-cooled reactors in the USSR.** Ponomarev-Stepnoi, N.N. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow (USSR). Inst. Atomnoj Ehnergii); Grebennik, V.N. International Atomic Energy Agency, Vienna (Austria). International Working Group on Gas-Cooled Reactors. Dec 1989. (CONF-8901194–: 8. meeting of the international working group on gas-cooled reactors, Vienna (Austria), 30 Jan 1989). In *Eighth meeting of the International Working Group on Gas-Cooled Reactors Vienna, 30 January - 1 February 1989. Summary report. Part 2.* Order Number DE90634104. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The analysis of the heat and energy market has shown that in addition to the conventional high power NPP there is need for development of a small and medium power nuclear energy source. R

and D works on a number of pilot plants of various capacities of HTGR are being carried out in the USSR. The VTR-M modular reactor with a unit power of 200-300 MW(th) is a low power pilot unit. Higher power demand for large identical complexes can be reached by use of several (from 2 to 5) reactor modules of the same type. Various designs of modular reactors with different arrangements of the main equipment, direction of helium flow, number of coolant loops have been considered. The works are in progress on the VG-400 pilot plant with thermal power of 1060 MW intended for co-generation of high temperature heat, steam and also electricity generation. 4 refs, 5 figs, 3 tabs.

40645 (IWGGCR–20-2, pp. 31-32) **The UK gas-cooled reactor programme - Progress report 1988.** Askew, J.R. (UKAEA Northern Research Labs., Risley (UK)). International Atomic Energy Agency, Vienna (Austria). International Working Group on Gas-Cooled Reactors. Dec 1989. (CONF-8901194–: 8. meeting of the international working group on gas-cooled reactors, Vienna (Austria), 30 Jan 1989). In *Eighth meeting of the International Working Group on Gas-Cooled Reactors Vienna, 30 January - 1 February 1989. Summary report. Part 2.* Order Number DE90634104. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

This paper summarises key developments during 1988 on the 26 Magnox reactors and 14 AGRs now operating in the UK. Details are given of long-term safety reviews of the Berkeley and Bradwell Magnox stations which resulted in a decision by CEGB to cease generation at Berkeley but to continue operation at Bradwell. The summary of operating experience with the AGRs concentrates on the completion of construction and successful commissioning of the second generation AGRs at Heysham 2 and Torness. An appended article by John Wilson, Deputy Director of the UKAEA's gas-cooled reactor R and D programme, gives details of the aims and achievements of the programme during 1988. (author).

40646 (IWGGCR–20-2, pp. 14-16) **HTR projects in the Federal Republic of Germany.** Balthesen, E. (Kernforschungsanlage Juelich GmbH (Germany, F.R.)). International Atomic Energy Agency, Vienna (Austria). International Working Group on Gas-Cooled Reactors. Dec 1989. (CONF-8901194–: 8. meeting of the international working group on gas-cooled reactors, Vienna (Austria), 30 Jan 1989). In *Eighth meeting of the International Working Group on Gas-Cooled Reactors Vienna, 30 January - 1 February 1989. Summary report. Part 2.* Order Number DE90634104. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Poster presentation. HTGR TYPE REACTORS/reactor operation; DUAL-PURPOSE POWER PLANTS; FEDERAL REPUBLIC OF GERMANY; PLANNING; RESEARCH PROGRAMS

40647 (Juel–2331) **The viscous fluid as a model for the pebble flow in high temperature reactors.** Scherer, W. Kernforschungsanlage Juelich GmbH (Germany, F.R.). Inst. fuer Reaktorentwicklung. Dec 1989. 63p. (In German). Order Number DE90510150. Available from NTIS (US Sales Only), PC A04/MF A01.

The flow of fuel elements in a Pebble-Bed High Temperature Reactor is described with a fluid flow model. Starting from the equations of motion for a noncompressible fluid and using the computer code TWODEPEP a flow model is established for the Thorium High Temperature Reactor THTR-300. In comparison to experimental data and to therefrom derived analytical expressions velocities, pebble tracks and residence spectra are discussed. It is shown, that the main characteristics of the pebble flow can be reproduced with the fluid model if gliding along the vessel surface is accounted for. (orig.).

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40648 (BARC–1474) **A final report on stress analysis of seal disc of 500 MWe PHWR.** Chawla, D.S. (Bhabha Atomic Research Centre, Bombay (India). Reactor Engineering Div.); Dutta, B.K.; Kushwaha, H.S.; Kakodkar, A.; Sanatkumar, A. Bhabha Atomic Research Centre, Bombay (India). 1989. 25p. Order Number DE90634117. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

In Pressurised Heavy Water Reactor (PHWR) on-power refuelling is done by use of fuelling machine. Before refuelling, sealing plug assembly is removed from the end-fitting of the coolant channel and after refuelling the sealing plug is reinstalled back in to the end-fitting. The seal disc is a part of sealing plug assembly. Its function is to create sealing action for the heavy water inside the coolant channel. A systematic developmental work is done to arrive at a final configuration of the seal disc. This is done to minimise the stresses in the body of the seal disc and at the same time to obtain required seating reaction to avoid heavy water leakage. It is observed that stresses computed for the final configuration by linear elastic analysis are more than the allowable value as per ASME Section III, Division 1. This calls for elasto-plastic analysis to find out collapse load to satisfy ASME codal limits as per special provision of NB-3228.1 (1986). The elasto-plastic analysis showed that the seal disc meets ASME codal limits for all stages of loading. (author). 8 refs., 2 tabs., 7 figs.

2105 Power Reactors, Breeding

Refer also to citation(s) 40613, 40675, 40705, 40706, 40707, 40708, 40709, 40710, 40711, 40712, 40713, 40714, 40715, 40716, 40717, 40718, 40719, 40720, 40721, 40722, 40723, 40724, 40726, 40727, 40728, 40774, 40791, 42271

40649 (CEA-CONF–9957) **D.E.M.T. Experimental and analytical studies on seismic isolation.** Gantenbein, F.; Buland, P. CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Dept. d'Etudes Mecaniques et Thermiques. 1989. 23p. (CONF-890810–: Seminar on small and medium sized reactors, design, safety and marketing potential, San Diego, CA (USA), 21-23 Aug 1989). Order Number DE90508372. Available from NTIS (US Sales Only), PC A03/MF A01.

The various studies which have been performed in C.E.A./ D.E.M.T. will be reviewed in the paper. They are experimental or theoretical and related to the overall behavior of isolated structures. Among the experimental work one can notice: - the seismic tests on a shaking table of a concrete cylinder isolated by sliding neoprene pads, - the vibrational tests on the reaction mass of TAMARIS seismic facility. The analytical work consists of dynamic calculation method development: - for the soil structure interaction in case of pads interposed between an upper raft and pedestals; - for the time history calculation of sliding structures; - for fluid structure interaction (coupling of fluid and structure motion or sloshing modes). Finally comments will be given on the seismic isolation consequencies for the analysis of F.B.R. vessels: the modes can no more be considered independent (SRSS method leads to important errors), the sloshing increases.

40650 (CEA-CONF–9988) **F.B.R. core seismic analysis.** Brochard, D.; Buland, P.; Hammami, L.; Gantenbein, F. CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Dept. d'Etudes Mecaniques et Thermiques. 1989. 9p. (CONF-890855–: 10. international conference on Structural Mechanics in Reactor Technology (SMIRT), Anaheim, CA (USA), 14-18 Aug 1989). Order Number DE90508364. Available from NTIS (US Sales Only), PC A02/MF A01.

FBR cores are composed of a great number of subassemblies of various types. These subassemblies are separated by small gaps and immersed in a fluid. During a seism, shocks may occur between subassemblies inducing a nonlinear behaviour of the core. The two phenomena which mainly influence the response of the core are the fluid structure interaction and the impacts between subassemblies. To study the core response, methods have been developed and validated through tests on the core mock-up RAPSODIE. The aim of this paper is to present the tests results corresponding at different levels of excitation, in air and in water, and different configurations of the core (free standing and barrel restrained). Then we will present the methods to interpret these results in pointing out the methods especially devoted to the analysis of the global fluid structure interaction (homogeneization).

40651 (CONF-900804–30) **EBR-2 [Experimental Breeder Reactor-2] test programs.** Sackett, J.I. (Argonne National Lab., Idaho Falls, ID (USA)); Lehto, W.K.; Lindsay, R.W.; Planchon,

H.P.; Lambert, J.D.B.; Hill, D.J. Argonne National Lab., Idaho Falls, ID (USA). [1990]. 16p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract W-31109-ENG-38. From International topical meeting on fast reactor safety; Snowbird, UT (USA); 12-16 Aug 1990. Order Number DE90013893. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

The Experimental Breeder Reactor-2 (EBR-2) is a sodium cooled power reactor supplying about 20 MWe to the Idaho National Engineering Laboratory (INEL) grid and, in addition, is the key component in the development of the Integral Fast Reactor (IFR). EBR-2's testing capability is extensive and has seen four major phases: (1) demonstration of LMFBR power plant feasibility, (2) irradiation testing for fuel and material development, (3) testing the off-normal performance of fuel and plant systems and (4) operation as the IFR prototype, developing and demonstrating the IFR technology associated with fuel and plant design. Specific programs being carried out in support of the IFR include advanced fuels and materials development, advanced control system development, plant diagnostics development and component testing. This paper discusses EBR-2 as the IFR prototype and the associated testing programs. 29 refs.

40652 (CONF-900917–6) **Recent progress in the development of metallic fuel.** Seidel, B.R. (Argonne National Lab., Idaho Falls, ID (USA)); Batte, G.L.; Dodds, N.E.; Lahm, C.E.; Pahl, R.G.; Tsai, H.C. Argonne National Lab., IL (USA). [1990]. 12p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract W-31109-ENG-38. From American Nuclear Society topical meeting on safety of noncommercial nuclear reactor research and irradiation facilities; Boise, ID (USA); 30 Sep - 3 oct 1990. Order Number DE90013664. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

Tests to date demonstrate that metallic fuel for advanced liquid metal reactors performs well, is easily reprocessed and refabricated and provides inherent reactor safety within an economic design. The behavior and performance of metallic fuel is key to the demonstration of the Integral Fast Reactor (IFR) concept at Argonne National Laboratory. Since 1985, more than 40 assemblies of experimental fuel in addition to the standard metallic driver fuel for Experimental Breeder Reactor 2 (EBR-2)have been irradiated; several more continue to be designed and fabricated. Results have characterized the influence of a wide range of fabrication, design and material variables upon irradiation behavior throughout the fuel lifetime under normal and upset conditions including operation with breached cladding. Results of test, both in- and out-of-reactor, indicate that metallic fuel is readily and economically fabricated, capable of achieving high exposure and long reactor residence times, and possesses unique and promising safety features. 9 refs., 6 figs.

40653 (CONF-900917–7) **EBR-2 [Experimental Breeder Reactor-2], IFR [Integral Fast Reactor] prototype testing programs.** Lehto, W.K. (Argonne National Lab., Idaho Falls, ID (USA). EBR-II Div.); Sackett, J.I.; Lindsay, R.W.; Planchon, H.P.; Lambert, J.D.B. Argonne National Lab., IL (USA). [1990]. 15p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract W-31109-ENG-38. From American Nuclear Society topical meeting on safety of noncommercial nuclear reactor research and irradiation facilities; Boise, ID (USA); 30 Sep - 3 oct 1990. Order Number DE90013665. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

The Experimental Breeder Reactor-2 (EBR-2) is a sodium cooled power reactor supplying about 20 MWe to the Idaho National Engineering Laboratory (INEL) grid and, in addition, is the key component in the development of the Integral Fast Reactor (IFR). EBR-2's testing capability is extensive and has seen four major phases: (1) demonstration of LMFBR power plant feasibility, (2) irradiation testing for fuel and material development. (3) testing the off-normal performance of fuel and plant systems and (4) operation as the IFR prototype, developing and demonstrating the IFR technology associated with fuel and plant design. Specific programs being carried out in support of the IFR include advanced fuels and materials development and component testing. This paper discusses EBR-2 as the IFR prototype and the associated testing programs. 29 refs.

40654 (IWGFR–70) **Status of national programmes on fast breeder reactors: Twenty-second annual meeting Vienna, 18-21 April 1989.** International Atomic Energy Agency, Vienna (Austria). International Working Group on Fast Reactors. Jul 1989. 180p. (CONF-8904364–: 22. annual meeting of the International Working Group on Fast Reactors, Vienna (Austria), 18-21 Apr 1989). Order Number DE90634121. Available from NTIS (US Sales Only), PC A09/MF A01; OSTI; INIS.

The twenty-second Annual Meeting of the International Working Group on Fast Reactors took place in Vienna, 18-21 April 1989. Nineteen representatives from twelve Member States and International Organizations attended the Meeting. This publication is a collection of presentations in which the participants reported the status of their national programmes on fast breeder reactors. A separate abstract was prepared for each of the twelve papers from this collections. Refs, figs, tabs and 1 graph.

40655 (IWGFR–70, pp. 5-14) **The development of fast reactors in France in 1988.** Asty, M. (CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France)); Cambillard, E. International Atomic Energy Agency, Vienna (Austria). International Working Group on Fast Reactors. Jul 1989. (In French). (CONF-8904364–: 22. annual meeting of the International Working Group on Fast Reactors, Vienna (Austria), 18-21 Apr 1989). In *Status of national programmes on fast breeder reactors: Twenty-second annual meeting Vienna, 18-21 April 1989.* Order Number DE90634121. Available from NTIS (US Sales Only), PC A09/MF A01; OSTI; INIS.

During the last year main activities in France were concentrated on EFR and restart of Superphenix 1. The reactor Phenix load factor was 72.39%. Research work on optimization of structural materials was continued. 45 refuelling cycles were performed by January 1989. Inspection of the Superphenix 1 reactor vessel was successfully fulfilled by MIR ultra-sonic device. In January 1989 the reactor was restarted. (author). 4 figs.

40656 (IWGFR–70, pp. 15-35) **Status of fast breeder reactor development in the Federal Republic of Germany, Belgium and the Netherlands.** Hueper, R. (Kernforschungszentrum Karlsruhe GmbH (Germany, F.R.). Projekt Schneller Brueter). International Atomic Energy Agency, Vienna (Austria). International Working Group on Fast Reactors. Jul 1989. (CONF-8904364–: 22. annual meeting of the International Working Group on Fast Reactors, Vienna (Austria), 18-21 Apr 1989). In *Status of national programmes on fast breeder reactors: Twenty-second annual meeting Vienna, 18-21 April 1989.* Order Number DE90634121. Available from NTIS (US Sales Only), PC A09/MF A01; OSTI; INIS.

The results of activities carried out by the DeBeNe partners in 1988 have been compiled in this report. The 1989 KNK II experimental program will focus on the management of fuel element failures. This includes in particular post-irradiation examinations in the hot cells and the THIBO experiments (thermally induced fuel rod oscillation). For this program, nine permits were received in 1988 for the installation and operation of test systems, including a new facility for localizing failed fuel elements. Increasing the purity of sodium is the purpose of a cesium trap recently installed, and of modifications to an oxygen probe operated for test purposes. The SNR 300 project is being continued within the framework of the "holding phase". The objective of this phase of operation is to keep the reactor plant in the loading and operational states and execute planning within the licensing procedure necessary to obtain the next partial permit. R and D work was concentrated on fuel and materials development, safety, physics, and components development. Materials for fuel, blanket, and absorber elements were studied and further developed with a view to very high burnup. In the sector of physics, the engineering design and the nuclear design of large breeders call for a reduction of the margins of uncertainty in reliable predictions of the major reactor parameters. The development of the joint European cell code, ECCO (European Cell Code) has progressed far enough in the meantime to allow the criticality parameter, k_{eff}, of a cell arrangement to be calculated with ECCO for the first time at UKAEA Winfrith, the central agency for carrying out the development work. One of the major

aspects covered in safety studies is the complex of fuel rod failures, loss of coolant flow, and power transients as possible causes of accidents. (Abstract Truncated)

40657 (IWGFR–70, pp. 36-50) **A review of the Indian fast reactor programme.** Chetal, S.C. (Indira Gandhi Centre for Atomic Research, Kalpakkam (India)). International Atomic Energy Agency, Vienna (Austria). International Working Group on Fast Reactors. Jul 1989. (CONF-8904364–: 22. annual meeting of the International Working Group on Fast Reactors, Vienna (Austria), 18-21 Apr 1989). In *Status of national programmes on fast breeder reactors: Twenty-second annual meeting Vienna, 18-21 April 1989.* Order Number DE90634121. Available from NTIS (US Sales Only), PC A09/MF A01; OSTI; INIS.

Fast Breeder Test Reactor (FBTR) in India is ready for restart. Satisfactory progress has been made in the design of Prototype Fast Breeder Reactor (PFBR). Conceptual design work for the important systems and components has been completed. Cost estimation is in progress. Detailed project report for the financial sanction is under completion stage and is planned to be submitted to the Government this year. Draft Safety criteria prepared by a sub-committee on behalf of the Regulatory Board have been discussed and will be issued shortly. (author).

40658 (IWGFR–70, pp. 51-55) **A review of the Italian fast reactor programme.** Pierantoni, F. (ENEA, Bologna (Italy)); Tavoni, R. International Atomic Energy Agency, Vienna (Austria). International Working Group on Fast Reactors. Jul 1989. (CONF-8904364–: 22. annual meeting of the International Working Group on Fast Reactors, Vienna (Austria), 18-21 Apr 1989). In *Status of national programmes on fast breeder reactors: Twenty-second annual meeting Vienna, 18-21 April 1989.* Order Number DE90634121. Available from NTIS (US Sales Only), PC A09/MF A01; OSTI; INIS.

The result of the referenda held in Italy in November 1987 on some nuclear issues, and the subsequent attitude of the main political parties led to a sharp cut-back of nuclear activities in Italy as far as both construction and operation of nuclear plants are concerned. A new PEN (National Energy Plan), already approved by the government for submission to parliament, calls, however, for a programme of research and industrial development of reactors with inherent and passive safety features. Such a programme must be carried out in a framework of international co-operation. In addition to the Italian contribution to R and D activities performed under the European Agreements some further activities have been performed on Esmeralda Programme, seismic isolation, Integrity of structures and Primary and Intermediate Pumps. (author). 2 tabs.

40659 (IWGFR–70, pp. 55-86) **A review of the fast reactor programme in Japan.** Matsuno, Y. (Power Reactor and Nuclear Fuel Development Corp., Tokyo (Japan)). International Atomic Energy Agency, Vienna (Austria). International Working Group on Fast Reactors. Jul 1989. (CONF-8904364–: 22. annual meeting of the International Working Group on Fast Reactors, Vienna (Austria), 18-21 Apr 1989). In *Status of national programmes on fast breeder reactors: Twenty-second annual meeting Vienna, 18-21 April 1989.* Order Number DE90634121. Available from NTIS (US Sales Only), PC A09/MF A01; OSTI; INIS.

The FBR programme in Japan has shown a steady progress, Reactor Joyo commenced the 17th duty cycle operation with MK-III core. Monju construction was 63.5% complete as of the end of February 1989, including design, manufacturing and construction at the site. Overall site work is now 89% complete. In 1988 JAPC evaluated the Demonstration Fast Breeder Reactor (DFBR) plant maintainability on both pool design and Loop Design. In 1989 JAPC is expected to start the conceptual design for the demonstration of FBR. (author). Figs, 1 tab.

40660 (IWGFR–70, pp. 87-105) **Promotion of research and development for fast breeder reactors in Japan.** International Atomic Energy Agency, Vienna (Austria). International Working Group on Fast Reactors; Atomic Energy Commission, Tokyo (Japan). Jul 1989. (CONF-8904364–: 22. annual meeting of the International Working Group on Fast Reactors, Vienna (Austria), 18-21 Apr 1989). In *Status of national programmes on fast breeder reactors: Twenty-second annual meeting Vienna, 18-21 April 1989.* Order Number DE90634121. Available from NTIS (US Sales Only), PC A09/MF A01; OSTI; INIS.

The "Long-term Program for Development and Utilization of Nuclear Energy" by Japan Atomic Energy Commission (JAEC) plans to develop fast breeder reactors (FBRs) as the mainstay of Japan's future nuclear power generation. For the development of the FBR, the main principle is to pursue the establishment of FBR plutonium utilization systems, which are superior to the LWR uranium utilization systems. The above program also states as follows: "Incessant efforts, with proper co-operation of the public and private sectors, will be required for a considerably long time for FBR development, and the concrete measures to be implemented in this connection will be discussed, hereafter, in continuation at the Advisory Committee on FBR Development Program of the Atomic Energy Commission". It was clearly stated in the "Long-term Program" that utilities would play a leading role in the design, construction, and operation of DFBRs to follow "Monju". They have entrusted Japan Atomic Power Company (JAPC) with the above tasks. Technical verification and demonstration tests for seismic design and feasibility studies of main components are being conducted with government support. Regarding the nuclear fuel cycle, PNC has been developing FBR fuel reprocessing technologies. Currently, the Recycle Equipment Test Facility (RETF) is being designed to conduct engineering-scale tests. A pilot plant is planned to start operation after 2000 assuming positive results of the tests. (author).

40661 (IWGFR–70, pp. 106-123) **Status of fast reactor activities in the USSR.** Troyanov, M.F. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Obninsk (USSR). Fiziko-Ehnergeticheskij Inst.); Rinejskij, A.A. International Atomic Energy Agency, Vienna (Austria). International Working Group on Fast Reactors. Jul 1989. (In Russian). (CONF-8904364–: 22. annual meeting of the International Working Group on Fast Reactors, Vienna (Austria), 18-21 Apr 1989). In *Status of national programmes on fast breeder reactors: Twenty-second annual meeting Vienna, 18-21 April 1989.* Order Number DE90634121. Available from NTIS (US Sales Only), PC A09/MF A01; OSTI; INIS.

Four fast reactors are in operation in the USSR now: BR-10, BOR-60, BN-350 and BN-600. Load factor of BN-600 reactor has reached the highest mark since the beginning of operation: 76.5%. On the basis of operational experience of running reactors design of more powerful commercial size BN-800 power reactor has been completed recently and construction work has started at the Beloyarsk. The BN-1600 reactor is considered to be the prototype of future commercial reactors. In 1988, the results of its development were reviewed and it was decided to extend its design approach with the aim to find some additional solutions to provide higher safety and better economics. (author). Figs and tabs.

40662 (IWGFR–70, pp. 128-148) **Status of liquid metal reactor development in the United States of America.** Griffith, J.D. (Department of Energy, Washington, DC (USA). Office of Nuclear Energy Programs); Horton, K.E. International Atomic Energy Agency, Vienna (Austria). International Working Group on Fast Reactors. Jul 1989. (CONF-8904364–: 22. annual meeting of the International Working Group on Fast Reactors, Vienna (Austria), 18-21 Apr 1989). In *Status of national programmes on fast breeder reactors: Twenty-second annual meeting Vienna, 18-21 April 1989.* Order Number DE90634121. Available from NTIS (US Sales Only), PC A09/MF A01; OSTI; INIS.

The United States has made substantial progress in achieving LMR programme objectives. A decision was made in 1988 to select the General Electric ALMR concept known as PRISM (Power Reactor Innovative Safe Module) for advanced conceptual design. A 3-year contract was awarded to General Electric in January of this year for concentrated trade-off studies and advanced design development. The strategy is to integrate those advancements that best meet programme objectives into a national ALMR system concept. (author). 8 figs.

40663 (IWGFR–70, pp. 149-167) **A review of the European collaborative programme on fast reactors.** European R and D Steering Committee. International Atomic Energy Agency, Vienna (Austria). International Working Group on Fast Reactors. Jul 1989. (CONF-8904364–: 22. annual meeting of the International Working Group on Fast Reactors, Vienna (Austria), 18-21 Apr 1989). In

Status of national programmes on fast breeder reactors: Twenty-second annual meeting Vienna, 18-21 April 1989. Order Number DE90634121. Available from NTIS (US Sales Only), PC A09/MF A01; OSTI; INIS.

Considerable progress has been made in the European Fast Reactor R and D Collaboration during 1988. In parallel with the technical achievements, 1988 has been notable for the determination and willingness to adapt and improve the various structures and procedures in the organization of the European Collaboration. Three important agreements on EFR were signed in Bonn, Federal Republic of Germany on 16 February 1989: Industrial agreement, as a basis for planning, design, future construction and marketing of EFR; R and D agreement on the content and extent of R and D support for EFR design; SERENA-FASTEC agreement on know-how pool and royalties. (author). 1 tab.

40664 (IWGFR–70, pp. 173-179) **The Argentine-Brazilian fast reactor programme.** Gho, C.J. (Comision Nacional de Energia Atomica, Bariloche (Argentina)); Mauricio, A. International Atomic Energy Agency, Vienna (Austria). International Working Group on Fast Reactors. Jul 1989. (CONF-8904364–: 22. annual meeting of the International Working Group on Fast Reactors, Vienna (Austria), 18-21 Apr 1989). In *Status of national programmes on fast breeder reactors: Twenty-second annual meeting Vienna, 18-21 April 1989.* Order Number DE90634121. Available from NTIS (US Sales Only), PC A09/MF A01; OSTI; INIS.

This paper summarizes the Argentine-Brazilian Fast Reactor Programme and gives reasons for the decision of a binational venture. The work carried out by both countries is described, showing how they complement each other, with the corresponding saving of resources. The main objectives of the Programme and tentative schedules in three progressing integrating stages are given and the present nuclear know-how in each country is identified as a good starting point. The paper also gives some details regarding the economical and human resources involved. (author). 1 graph.

40665 (KFK–4705) **Distributions of velocity and turbulence in wall subchannels of rod bundles downstream of a spacer grid with a strong partial blockage.** Rehme, K. Kernforschungszentrum Karlsruhe GmbH (Germany, F.R.). Inst. fuer Neutronenphysik und Reaktortechnik; Kernforschungszentrum Karlsruhe GmbH (Germany, F.R.). Projekt Nukleare Sicherheit. Apr 1990. 64p. (In German). Order Number DE90510181. Available from NTIS (US Sales Only), PC A04/MF A01.

Measurements of the mean velocity, of the wall shear stresses, and of the turbulence have been performed in two wall subchannels (P/D = 1.223; W/D = 1.183) of a rod bundle of four parallel rods arranged in a rectangular channel for three axial planes. A spacer grid of the SNR-type was inserted in the rod bundle to fix the rods. In contrast to previous investigations, however, the spacer grid was partially blocked. The measurements were performed at ratios of distance between the spacer grid and the measuring plane and the hydraulic diameter of L/D_h = 32.76, 16.91 and 8.44, respectively. The Reynolds number of this investigation was Re = 1.28×10^5. Strong changes of the distributions of velocity and turbulence are found compared with the previous results downstream of a spacer grid without a partial blockage. The redistribution of the mass flow and of the turbulence intensities increase with decreasing L/D_h. The kinetic energy of turbulence strongly increases with decreasing L/D_h. (orig.).

40666 (WHC-SA–0842) **The proven performance of liquid metal breeder reactors using mixed oxide fuel.** Munn, W.I. Westinghouse Hanford Co., Richland, WA (USA). Jun 1990. 6p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC06-87RL10930. (CONF-9006178–2: 1990 Society of Women Engineers national convention and student conference, New York, NY (USA), 24 Jun - 1 jul 1990). Order Number DE90014340. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

Since the first liquid-metal-cooled reactors were constructed in the 1950's, a variety of fuel types has been utilized both in the United States and abroad. Nearly forty years of experience have provided ample evidence of the high level of success achieved by the use of mixed oxide (UO/PuO) in liquid metal fast breeder reactors. This paper will outline the fuel experience of the Fast Flux Test Facility, the largest liquid metal fast breeder research reactor in the world. 10 refs., 1 fig.

2106 Power Reactors, Auxiliary, Mobile, Package, and Transportable

40667 (CEA-CONF–10000) **Concept, design approaches suited to space nuclear power systems in the range of 20 kWE.** Tilliette, Z.P.; Carre, F.; Proust, E. CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Dept. d'Etudes Mecaniques et Thermiques. 1989. 6p. (CONF-890815–: 24. intersociety energy conversion engineering conference, Arlington, VA (USA), 6-11 Aug 1989). Order Number DE90508406. Available from NTIS (US Sales Only), PC A02/MF A01.

Given the variety of possible missions and flight dates, it seems advisable to widen the basis for future technical choices within the French preliminary studies of 20-kWe space nuclear power systems. In addition to the fast spectrum, liquid metal-cooled reactor presently considered as a reference, shorter development term system, gas- and Na(K)-cooled thermal spectrum reactors are being investigated. The need for adequate ZrH moderator temperature conditions can be satisfied through a Brayton cycle conversion subsystem featuring two separate, high temperature-heat pipes and low temperature-pumped loop radiators. The penalty in efficiency and in radiator area, resulting from the wanted lower reactor inlet temperature, can be limited, particularly in the case of the higher temperature, gas-cooled reactor system. A multiple, pivoting tubes, low temperature radiator concept is proposed; it avoids an extension of the related structural support frame beyond the conversion subsystem region in flight configuration. Arrangements peculiar to small reactors and two-turbo-generator diagrams for reliability reasons are presented. Provisional, not yet optimized, thermal management mass estimates are evaluated.

40668 (CEA-CONF–10001) **Status of the CNES-CEA joint program on space nuclear Brayton systems.** Carre, F.; Proust, E.; Chaudourne, S.; Keirle, P.; Tilliette, Z.; Vrillon, B. CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Dept. d'Etudes Mecaniques et Thermiques. 1989. 9p. (CONF-890815–: 24. intersociety energy conversion engineering conference, Arlington, VA (USA), 6-11 Aug 1989). Order Number DE90508407. Available from NTIS (US Sales Only), PC A02/MF A01.

A cooperative program between the French Centre National d'Etudes Spatiales (CNES) and the Commissariat a l'Energie Atomique (CEA) was initiated in 1983, to investigate the possible development of 20 to 200 kWe space nuclear power systems to be launched by the next version of the European launcher, Ariane V. After completion in 1986 of preliminary conceptual studies of a reference 200 kWe turbo-electric power system, an additional 3 year study phase was decided, with the double objective of assessing the potential advantage of nuclear power systems versus solar photovoltaic or dynamic systems in the 20 kWe power range, and comparing various reactor candidate technologies and system options for 20 kWe space nuclear power systems, likely to meet the projected energy needs of future European space missions. A comprehensive program including conceptual design studies, operating transient analyses and technology base assessment, is currently applied to a few reference concepts of 20 kWe nuclear Brayton and thermoelectric systems, in order to establish sound technical and economical bases for selecting the design options and the development strategy of a first space nuclear power system in Europe.

40669 (N–90-21108) **A radiological assessment of nuclear power and propulsion operations near Space Station Freedom. Contract report, January 1988-January 1990.** Bolch, W.E.; Thomas, J.K.; Peddicord, K.L.; Nelson, P.; Marshall, D.T.; Busche, D.M. Texas A and M Univ., College Station, TX (USA). Mar 1990. 115p. (NASA-CR–185185;NAS–1.26:185185). Available from NTIS, PC A06/MF A01.

Scenarios were identified which involve the use of nuclear power systems in the vicinity of Space Station Freedom (SSF) and their radiological impact on the SSF crew was quantified. Several of the developed scenarios relate to the use of SSF as an evolutionary transportation node for lunar and Mars missions. In particular, radiation doses delivered to SSF crew were calculated for both the

launch and subsequent return of a Nuclear Electric Propulsion (NEP) cargo vehicle and a Nuclear Thermal Rocket (NTR) personnel vehicle to low earth orbit. The use of nuclear power on co-orbiting platforms and the storage and handling issues associated with radioisotope power systems were also explored as they relate to SSF. A central philosophy in these analyses was the utilization of a radiation dose budget, defined as the difference between recommended dose limits from all radiation sources and estimated doses received by crew members from natural space radiations. Consequently, for each scenario examined, the dose budget concept was used to identify and quantify constraints on operational parameters such as launch separation distances, returned vehicle parking distances, and reactor shutdown times prior to vehicle approach. The results indicate that realistic scenarios do not exist which would preclude the use of nuclear power sources in the vicinity of SSF. The radiation dose to the SSF crew can be maintained at safe levels solely by implementing proper and reasonable operating procedures.

40670 (WHC-SA–0817) **SP-100 design, safety, and testing.** Smith, G.L.; Cox, C.M.; Mahaffey, M.K. Westinghouse Hanford Co., Richland, WA (USA). May 1990. 17p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC06-87RL10930. (CONF-900917–2: American Nuclear Society topical meeting on safety of non-commercial nuclear reactor research and irradiation facilities, Boise, ID (USA), 30 Sep - 3 oct 1990). Order Number DE90012643. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The SP-100 Program is developing a nuclear reactor power system that can enhance and/or enable future civilian and military space missions. The program is directed to develop space reactor technology to provide electrical power in the range of tens to hundreds of kilowatts. The major assembly test is to be conducted at the Hanford Site near Richland, Washington, and is designed to validate the performance of the 2.4 Mwt nuclear and heat transport assembly. 9 refs., 4 figs.

2107 Regulation and Licensing

Refer also to citation(s) 40792, 40797, 40798, 40799, 40803

40671 (AERB/M/NSD–3) **Safety manual governing the authorization procedure for nuclear power plant/project.** Atomic Energy Regulatory Board, Bombay (India). 1989. 64p. Order Number DE90634373. Available from NTIS (US Sales Only), PC A04/MF A01; OSTI; INIS.

The manual specifies the procedures to be followed by Nuclear Power Corporation and other nuclear installations in India for securing authorization of different phases of any nuclear power plant/project (except decommissioning). Section I of the manual sets down the specific objectives of review and assessment of the applications for authorization. Section II describes the modalities of the authorization process which include general aspects, functions of authorization, requirements on the applicant, stages of the authorization process and schedule of submission for authorization. Section III deals with typical information to be submitted in support of application for authorization. Appendix I gives in detail guidelines for organisation and contents of safety analysis reports for power reactors. Appendix II indicates the typical documentary submissions in support of applications for commissioning and operating authorization. (M.G.B.).

40672 (NUREG–0750-Vol.31-Index1) **Indexes to Nuclear Regulatory Commission Issuances, January–March 1990.** Nuclear Regulatory Commission, Washington, DC (USA). Div. of Freedom of Information and Publications Services. 1990. 48p. Sponsored by Nuclear Regulatory Commission. Available from NTIS, PC A03/MF A01 - GPO; OSTI; INIS.

Digests and indexes for issuances of the Commission (CLI), the Atomic Safety and Licensing Appeal Panel (ALAB), the Atomic Safety and Licensing Board Panel (LBP), the Administrative Law Judge (ALJ), the Directors' Decisions (DD), and the Denials of Petitions for Rulemaking are presented in this document. These digests and indexes are intended to serve as a guide to the issuances. Information elements common to the cases heard and ruled upon are: case name (owner(s) of facility); full text reference (volume and pagination); issuance number; issues raised by appellants; legal citations (cases, regulations, and statutes); name of facility, Docket number; subject matter of issues and/or rulings; type of hearing (for construction permit, operating license, etc.); and type of issuance (memorandum, order, decision, etc.). These information elements are displayed in one or more of five separate formats arranged as follows: case name index; digests and headers; legal citations index; subject index; and facility index.

40673 (NUREG–1363-Vol.2) **Atomic Safety and Licensing Board Panel annual report, fiscal year 1989: Volume 2.** Cotter, B.P. Jr. Nuclear Regulatory Commission, Washington, DC (USA). Jul 1990. 59p. Sponsored by Nuclear Regulatory Commission. Available from NTIS, PC A04/MF A01 - GPO; OSTI; INIS.

In Fiscal Year 1989, the Atomic Safety and Licensing Board Panel (ASLBP) handled 40 proceedings involving the construction, operation and maintenance of commercial nuclear power reactors or other activities requiring a license from the Nuclear Regulatory Commission. This report summarizes, highlights and analyzes how the wide-ranging issues raised in these proceedings were addressed by the Judges and Licensing Boards of the ASLBP during the year. 5 figs., 3 tabs.

2108 Economics

Refer also to citation(s) 40350, 40602, 40803

40674 (IAEA-TECDOC–528) **Experience with WASP and MAED among IAEA Member States participating in the Regional Co-operative Agreement (RCA) in Asia and the Pacific Region: Proceedings of the RCA workshop on the WASP/MAED computer programs held in Kuala Lumpur, Malaysia 5-9 December 1988.** International Atomic Energy Agency, Vienna (Austria). Oct 1989. 293p. (CONF-8812139–: RCA workshop on the WASP/MAED coomputer programs, Kuala Lumour (Malaysia), 5-9 Dec 1988). Order Number DE90634346. Available from NTIS (US Sales Only), PC A13/MF A01; OSTI; INIS.

The report includes the proceedings and papers presented during the workshop on the experience with WASP/MAED computer programs among IAEA Member States participating in the regional co-operative agreement (RCA) in Asia and the Pacific Region, organized by the IAEA and held in Kuala Lumpur (Malaysia) between 5-9 December 1988. A separate abstract was prepared for each of the 14 papers presented. Refs, figs and tabs.

40675 (IAEA-TECDOC–528, pp. 55-70) **Energy modeling: The nuclear energy role for China's energy in the coming century and its development.** Guo Xingqu (China Inst. of Nuclear Industry Economics, Beijing (China)). International Atomic Energy Agency, Vienna (Austria). Oct 1989. (CONF-8812139–: RCA workshop on the WASP/MAED coomputer programs, Kuala Lumour (Malaysia), 5-9 Dec 1988). In *Experience with WASP and MAED among IAEA Member States participating in the Regional Co-operative Agreement (RCA) in Asia and the Pacific Region: Proceedings of the RCA workshop on the WASP/MAED computer programs held in Kuala Lumpur, Malaysia 5-9 December 1988.* Order Number DE90634346. Available from NTIS (US Sales Only), PC A13/MF A01; OSTI; INIS.

From scenarios about China's population and economic development, and based on the application of a computer model, China's energy forecast for the next century was determined as described in this paper. According to the results of the calculations and taking into account China's energy resources of various types, nuclear energy should play a main role (its share above 50%) in satisfying the demand after about 2040. Using a computer code, as a strategy to reach the above target before the middle of the next century, four developing ways for nuclear energy have been analyzed. It is pointed out that the best way for developing nuclear energy in China is to use metallic fuel to develop fast breeder reactors (FBRs). (author). 38 refs, 4 figs, 1 tab.

40676 (IAEA-TECDOC–528, pp. 71-92) **Electrical energy in India - Growth and prospects.** Roy, P.K. (Nuclear Power Corp. of India Ltd, Bombay (India)). International Atomic Energy Agency, Vienna (Austria). Oct 1989. (CONF-8812139–: RCA workshop on the WASP/MAED coomputer programs, Kuala Lumour (Malaysia), 5-9

Dec 1988). In *Experience with WASP and MAED among IAEA Member States participating in the Regional Co-operative Agreement (RCA) in Asia and the Pacific Region: Proceedings of the RCA workshop on the WASP/MAED computer programs held in Kuala Lumpur, Malaysia 5-9 December 1988.* Order Number DE90634346. Available from NTIS (US Sales Only), PC A13/MF A01; OSTI; INIS.

In spite of the tremendous increase, both, of gross installed capacity and the generation of electrical energy in India over the last four decades, the demand for power continues to outstrip supply. This paper discusses the historical pattern of growth of demand and supply, calculates the electricity coefficient and presents the basis on which demand forecasting/projection is carried out in India, while detailing out several independent projections of demand until the horizon year 2000 A.D. A range of supply options to meet this demand are then discussed. The "optimal" capacity additions to the year 2005 A.D., as defined by the "feasible cum-desirable solution" using the EGEAS and ISPLAN electric system generation expansion models, corresponding to a reliability level of 5% LOLP, is then highlighted. The "key inputs" in terms of financial resources, manpower and physical resources required to meet this additional capacity are also described. The Indian experience with WASP and some of its methodological limitations are also mentioned. Lastly, two important aspects - Transmission and distribution (T/D) - and load management practices, and their resultant strategic implications in reducing additional capacity requirements are described. Results of financial cost-benefit analysis as applied to improvements in T and D losses and improved load management techniques are also stated. (author). 12 tabs.

40677 (IAEA-TECDOC–528, pp. 93-102) **Recent exercise on WASP: An outlook for the Java system.** Sudarsono, B. (National Atomic Energy Agency, Jakarta (Indonesia)); Bunjamin, M.; Djokolelono, M. International Atomic Energy Agency, Vienna (Austria). Oct 1989. (CONF-8812139–: RCA workshop on the WASP/MAED coomputer programs, Kuala Lumour (Malaysia), 5-9 Dec 1988). In *Experience with WASP and MAED among IAEA Member States participating in the Regional Co-operative Agreement (RCA) in Asia and the Pacific Region: Proceedings of the RCA workshop on the WASP/MAED computer programs held in Kuala Lumpur, Malaysia 5-9 December 1988.* Order Number DE90634346. Available from NTIS (US Sales Only), PC A13/MF A01; OSTI; INIS.

The WASP program which had been installed in BATAN's IBM-4331 machine has recently been converted to be run in the newly installed VAX-8550 system without serious difficulties. The end product was modified to make full use of the VAX/VMS interactive ability, so that WASP runs are now highly simplified. In term of speed there is more than 30-fold improvement over the old IBM-4331. The paper briefly reviews recent WASP runs on the Java System and discusses the assumed parameters and results. These runs were made using 5% p.a. discount rate and coal price of 40$/T in 1990, whereas the varying parameters were: ENS cost, LOLP, depreciation method, capital cost and relevant forced outage rate. The study period of 1990-2015 was taken in view of the fact that nuclear introduction could be effected around the year 2000. The conclusion which emerges is that the nuclear option remains a robust alternative for the future development of the Java System. (author). 3 refs.

40678 (IAEA-TECDOC–528, pp. 115-131) **Long-term electric system expansion planning in Korea.** Poong Eil Juhn (Korea Atomic Energy Research Inst., Daeduk (Republic of Korea)); Young Gun Lee; Man Ki Lee. International Atomic Energy Agency, Vienna (Austria). Oct 1989. (CONF-8812139–: RCA workshop on the WASP/MAED coomputer programs, Kuala Lumour (Malaysia), 5-9 Dec 1988). In *Experience with WASP and MAED among IAEA Member States participating in the Regional Co-operative Agreement (RCA) in Asia and the Pacific Region: Proceedings of the RCA workshop on the WASP/MAED computer programs held in Kuala Lumpur, Malaysia 5-9 December 1988.* Order Number DE90634346. Available from NTIS (US Sales Only), PC A13/MF A01; OSTI; INIS.

The optimal mix of electric power capacity in Korea up to year 2001 is carried out by means of the WASP model using the scenario approach. In addition, sensitivity analysis in terms of fuel cost and capacity factor is also carried out. The scenario approach shows that the increment of nuclear capacity during the period of 1988-2001 is expected to be 6,650 MW, representing 32% of the total capacity increment. On the other hand, the capacity addition of coal power plants during the same period is to be 14,000 MW, representing 68% of the total capacity increment. The paper also gives some insight about Korea's economic planning and the past and future trends of energy/electricity consumption, and the current government policies to cope with demand in increases under a situation of limited endogenous resources. (author). 1 fig., 16 tabs.

40679 (IAEA-TECDOC–528, pp. 133-153) **Analysing the financial viability of WASP expansion plans using the FINPLAN model.** Ishan bin Haji Bakar, M. (National Electricity Board, Kuala Lumpur (Malaysia). Development Planning Dept.); Zamzam bin Jaafar, M. International Atomic Energy Agency, Vienna (Austria). Oct 1989. (CONF-8812139–: RCA workshop on the WASP/MAED coomputer programs, Kuala Lumour (Malaysia), 5-9 Dec 1988). In *Experience with WASP and MAED among IAEA Member States participating in the Regional Co-operative Agreement (RCA) in Asia and the Pacific Region: Proceedings of the RCA workshop on the WASP/MAED computer programs held in Kuala Lumpur, Malaysia 5-9 December 1988.* Order Number DE90634346. Available from NTIS (US Sales Only), PC A13/MF A01; OSTI; INIS.

The National Electricity Board of Malaysia recently acquired the Financial Planning (FINPLAN) Model from the International Atomic Energy Agency (IAEA) under an IAEA technical co-operation project. The project represents a first attempt by the IAEA to validate the suitability of FINPLAN to address the financial viability of a power investment programme under real utility environment. The FINPLAN model is a micro-computer program based on spreadsheets. An important feature of FINPLAN is that it utilizes techniques similar to those used by financial institutions to analyse the financing of large investment programmes. Another advantage of FINPLAN is that it only requires readily available commercial spreadsheet software and relatively inexpensive micro-computer systems. It is therefore very portable and could be easily transferred to other interested users. FINPLAN is intended to be used in conjunction with the WASP model in an iterative way. Firstly, WASP is used to determine the economically optimal expansion plan for a power generating system, and then FINPLAN is applied to determine whether this plan is financially viable; otherwise new WASP solutions may become necessary before an overall feasible solution is found for the system under study. This paper reports some of the main features of FINPLAN and the modifications introduced to the program to suit NEB's financial practice. Results from preliminary analyses of two hypothetical case studies using the "modified" FINPLAN are presented. (author). 1 ref., 16 figs.

40680 (IAEA-TECDOC–528, pp. 155-170) **Analysing NEB's system load profile using the MAED model.** Zamzam bin Jaafar, M. (National Electricity Board, Kuala Lumpur (Malaysia). Development Planning Dept.). International Atomic Energy Agency, Vienna (Austria). Oct 1989. (CONF-8812139–: RCA workshop on the WASP/MAED coomputer programs, Kuala Lumour (Malaysia), 5-9 Dec 1988). In *Experience with WASP and MAED among IAEA Member States participating in the Regional Co-operative Agreement (RCA) in Asia and the Pacific Region: Proceedings of the RCA workshop on the WASP/MAED computer programs held in Kuala Lumpur, Malaysia 5-9 December 1988.* Order Number DE90634346. Available from NTIS (US Sales Only), PC A13/MF A01; OSTI; INIS.

Published reports on the use of the MAED model, including the Users' Manual, mainly highlight the results derived from Module 1 of MAED, which is essentially a simplified version of the MEDEE model. Consequently, the important features and strength of Modules 2 and 3 are less wellknown, particularly to power utilities in developing countries. These modules are very suitable for analysing load management options to improve overall system load shape, thereby achieving better annual system load factor. This paper attempts to demonstrate the usefulness of these modules by

analysing the NEB's system load profile for 1986 so that comparisons can be made between actual values and calculated values. The simulations carried out are not comprehensive, but should be sufficient to show the important features of these modules. Graphical illustrations shown in the paper would give a better understanding of the data requirements and output of the modules. (author). 7 refs, 18 figs.

40681 (IAEA-TECDOC–528, pp. 171-194) **Ranking of hydro projects using WASP-III.** Salleh Serwan, M. (National Electricity Board, Kuala Lumpur (Malaysia). Development Planning Dept.); Tan, P.A.K.; Rozali, A.M. International Atomic Energy Agency, Vienna (Austria). Oct 1989. (CONF-8812139–: RCA workshop on the WASP/MAED coomputer programs, Kuala Lumour (Malaysia), 5-9 Dec 1988). In *Experience with WASP and MAED among IAEA Member States participating in the Regional Co-operative Agreement (RCA) in Asia and the Pacific Region: Proceedings of the RCA workshop on the WASP/MAED computer programs held in Kuala Lumpur, Malaysia 5-9 December 1988.* Order Number DE90634346. Available from NTIS (US Sales Only), PC A13/MF A01; OSTI; INIS.

The National Electricity Board (NEB) of Malaysia has three hydroelectric projects that could be implemented as part of its medium term generation development plan in Peninsular Malaysia. For each project, two probable rated outputs are identified. For one of the projects, the possibility of exploiting a nearby hydro potential is also economically assessed. This paper describes how WASP-III was utilised; firstly to select the more economical rating of each project with a respect to NEB integrated system, and secondly to rank the three hydro projects for the rated output selected. (author). figs, tabs.

40682 (IAEA-TECDOC–528, pp. 195-214) **An overview of the economic and energy situation in Pakistan.** Tariq, M.M. (Pakistan Atomic Energy Commission, Islamabad (Pakistan)); Naqvi, F. International Atomic Energy Agency, Vienna (Austria). Oct 1989. (CONF-8812139–: RCA workshop on the WASP/MAED coomputer programs, Kuala Lumour (Malaysia), 5-9 Dec 1988). In *Experience with WASP and MAED among IAEA Member States participating in the Regional Co-operative Agreement (RCA) in Asia and the Pacific Region: Proceedings of the RCA workshop on the WASP/MAED computer programs held in Kuala Lumpur, Malaysia 5-9 December 1988.* Order Number DE90634346. Available from NTIS (US Sales Only), PC A13/MF A01; OSTI; INIS.

The paper gives an overview of the economic and energy situation in Pakistan. It discusses the evolution of the gross domestic product (GDP) and of the primary energy consumption in the country. The indigenous energy resources are briefly described. Some of the results of the study carried out for assessment and projections of the medium to long term energy demand based on the MEDEE approach are outlined. The paper also includes the long term electrical energy and power forecasts made by the national electric utility - Water and Power Development Authority (WAPDA). (author). 13 refs, 3 figs, tabs.

40683 (IAEA-TECDOC–528, pp. 215-243) **WASP-III application to the Philippine Mindanao system.** Quintia, M.C. (National Power Corp., Quezon City (Philippines)); Sunico, L.J.S. International Atomic Energy Agency, Vienna (Austria). Oct 1989. (CONF-8812139–: RCA workshop on the WASP/MAED coomputer programs, Kuala Lumour (Malaysia), 5-9 Dec 1988). In *Experience with WASP and MAED among IAEA Member States participating in the Regional Co-operative Agreement (RCA) in Asia and the Pacific Region: Proceedings of the RCA workshop on the WASP/MAED computer programs held in Kuala Lumpur, Malaysia 5-9 December 1988.* Order Number DE90634346. Available from NTIS (US Sales Only), PC A13/MF A01; OSTI; INIS.

The WASP III computer model is applied in the formulation of an alternative power expansion plan for the predominantly hydro-based system of the Mindanao grid in southern Philippines. In the formulation of the program, two hydro models - one for reliability analysis and another for production costing calculation - are adopted. Related formulation procedure and assumptions are discussed at some length. The characteristics of existing and future projects are described in some detail including inflow statistics of candidate hydro plants. The methodology for scenario setting are also presented. Finally, the resulting expansion power plan is analyzed and the applicability of the WASP III model to this specific system is assessed. (author). 4 figs, 17 tabs.

40684 (IAEA-TECDOC–528, pp. 245-257) **Generation expansion planning at the Electricity Generating Authority of Thailand.** Chimklai, S. (Electricity Generating Authority of Thailand, Nonthaburi (Thailand)). International Atomic Energy Agency, Vienna (Austria). Oct 1989. (CONF-8812139–: RCA workshop on the WASP/MAED coomputer programs, Kuala Lumour (Malaysia), 5-9 Dec 1988). In *Experience with WASP and MAED among IAEA Member States participating in the Regional Co-operative Agreement (RCA) in Asia and the Pacific Region: Proceedings of the RCA workshop on the WASP/MAED computer programs held in Kuala Lumpur, Malaysia 5-9 December 1988.* Order Number DE90634346. Available from NTIS (US Sales Only), PC A13/MF A01; OSTI; INIS.

This paper describes the method of generation expansion planning which is carried out presently at the Electricity Generating Authority of Thailand (EGAT). It describes how the study is performed in order to obtain an expansion plan which meets the demand requirement, planning objectives and reliability level. The use of generation expansion planning models is also discussed to some detail. In addition, the present EGAT's power development plan is included as part of the paper to show the existing status as well as the long term profile of the power system of Thailand. (author). 3 refs, 2 figs, 2 tabs.

40685 (IAEA-TECDOC–528, pp. 259-270) **Experience in the use of the WASP/PC version in power planning for Viet Nam.** Nguyen Hong Phan (Viet Nam National Atomic Energy Inst., Hanoi (Viet Nam)). International Atomic Energy Agency, Vienna (Austria). Oct 1989. (CONF-8812139–: RCA workshop on the WASP/MAED coomputer programs, Kuala Lumour (Malaysia), 5-9 Dec 1988). In *Experience with WASP and MAED among IAEA Member States participating in the Regional Co-operative Agreement (RCA) in Asia and the Pacific Region: Proceedings of the RCA workshop on the WASP/MAED computer programs held in Kuala Lumpur, Malaysia 5-9 December 1988.* Order Number DE90634346. Available from NTIS (US Sales Only), PC A13/MF A01; OSTI; INIS.

The use of the WASP-3 computer model for planning the power generating system of Viet Nam started a few years ago and some studies have been carried out with this program by Viet Nam National Atomic Energy Institute. More recently, the new PC version of WASP-3 has been implemented at the Institute in order to overcome some of the problems connected with execution of the program in mainframe computers. This paper summarizes the main problems encountered in the use of this version within the context of Viet Nam conditions. A study undertaken by the Institute in order to analyze the economic benefits of interconnecting the two power systems of the country is also described in the paper. (author).

40686 (IAEA-TECDOC–528, pp. 271-290) **Shadow prices in Pakistan.** Elwan, I. (World Band, Washington, DC (USA). Energy Operations Div.); Markandya, A. International Atomic Energy Agency, Vienna (Austria). Oct 1989. (CONF-8812139–: RCA workshop on the WASP/MAED coomputer programs, Kuala Lumour (Malaysia), 5-9 Dec 1988). In *Experience with WASP and MAED among IAEA Member States participating in the Regional Co-operative Agreement (RCA) in Asia and the Pacific Region: Proceedings of the RCA workshop on the WASP/MAED computer programs held in Kuala Lumpur, Malaysia 5-9 December 1988.* Order Number DE90634346. Available from NTIS (US Sales Only), PC A13/MF A01; OSTI; INIS.

This paper reports the calculation of a set of shadow prices for Pakistan, undertaken originally in connection with the evaluation of a major investment in that country. These prices indicate the 'true' value which is to be attached to an input or output associated with a project or investment plan, as opposed to the observed value, which is frequently based on administered or distorted market prices. Hence they are of great relevance in any project or system wide evaluation exercise. The investment in question was the Kalabagh Dam Project, a multi-purpose irrigation and power development on the Indus River in Northern Pakistan. Given the massive size of the investment involved, and its likely impact on other sectors of the economy, it was decided that a full set of shadow or

accounting prices be calculated as a first step in the analysis of the project. This was done using data from a number of sources in the country, of which the principal one was an 87 sector input-output matrix. The method by which the data were used is described and critically evaluated in the paper, as are the main results and their implications. Finally, the key terms used in the paper are defined, for convenience, in an annex. (author). 9 refs, 3 tabs.

40687 (PNL–3594-Rev.10) **International Nuclear Fuel Cycle Fact Book: Revision 10.** Leigh, I.W.; Mitchell, S.J. Pacific Northwest Lab., Richland, WA (USA). Jan 1990. 300p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC06-76RL01830. Order Number DE90014702. Available from NTIS, PC A13/MF A01; OSTI; INIS; GPO Dep.

As the US Department of Energy (DOE) and DOE contractors have become increasingly involved with other nations in nuclear fuel cycle and waste management cooperative activities, a need has developed for a ready source of information concerning foreign fuel cycle programs, facilities, and personnel. This Fact Book was compiled to meet that need. The information contained in the International Nuclear Fuel Cycle Fact Book has been obtained from many unclassified sources: nuclear trade journals and newsletters; reports of foreign visits and visitors; CEC, IAEA, and OECD/NEA activities reports; proceedings of conferences and workshops, etc. The data listed do not reflect any one single source but frequently represent a consolidation/combination of information.

22 NUCLEAR REACTOR TECHNOLOGY

2201 Theory and Calculation

Refer also to citation(s) 40802

40688 (KFK–4695) **Calculation of the benchmark 20 of the OECD-NEA Working Group on Criticality Calculations.** Bernnat, W.; Keinert, J. Kernforschungszentrum Karlsruhe GmbH (Germany, F.R.). Inst. fuer Neutronenphysik und Reaktortechnik; Stuttgart Univ. (Germany, F.R.). Inst. fuer Kernenergetik und Energiesysteme. Mar 1990. 38p. (IKE–6-180). Order Number DE90510275. Available from NTIS (US Sales Only), PC A03/MF A01.

The benchmark 20 is a hypothetical criticality problem consisting of 2.5% enriched UO_2 spherical pelletes in borated water or borated water-UO_2 slurries. The volume fraction of the pellet to the slurry, the boron concentration, and the fraction of the total UO_2 in the slurry were varied. The main problem of this benchmark is the adequate treatment of resonances in the zone with borated water and UO_2 slurries. The criticality calculations for the benchmark were performed by means of the program system RSYST/CGM based on JEF-1 data. The neutron spectrum in the range of resolved resonances of U-238 (4 keV-3eV) was calculated by solving the slowing down equation for a large number of groups (lethargy-width 0.001) for a multicone-cell (first-collision P^{ik}-method). The dependency of the neutron sepctrum and the weighted cross-sections in the resonance range will be shown as a function of the UO_2 fraction in borated water for the pitches with UO_2 volume fractions 0.4 and 0.6 respectively. k-infinity was calculated for all variations with a 1D-cell-model in spherical geometry (white boundary conditions). The effect of the square pitch and triangular pitch was studied with a transport method (127 energy groups) based on 3D first-collision probabilities calculated by Monte Carlo. The results of these calculations show a very good agreement with a solution of CEA (CEA reference solution based on APOLLO/PIC and the CEA 86 library). (orig.).

40689 Evaluation of the delayed neutron importance factor with ENDF/B-V data. Biswas, D.; Kovacik, W.P.; White, J.R. *Transactions of the American Nuclear Society (USA),* 59: 318-319 (1989). (CONF-890604–: Annual meeting of the American Nuclear Society, Atlanta, GA (USA), 4-8 Jun 1989).

The delayed neutron importance factor (IBAR) is used to adjust the six-group delayed neutron data in reactivity computer measurements, such as those for control-rod worth. The delayed neutron fraction in each group is multiplied by IBAR to get the effective delayed neutron fraction. The IBAR accounts for the effects of the less energetic delayed neutrons on the multiplication of the system. As a part of the continuing effort to improve the agreement between measured and predicted reactivity parameters, a study was performed to determine the sensitivity of IBAR to different core conditions. The results of the analysis are given in the form of the percent of difference between the calculated and design value of IBAR. The primary observation is that IBAR is a relatively insensitive quantity. It is concluded that the IBAR value does not change substantially enough to warrant a change in the currently used design value, and a single value of IBAR is adequate for all core configurations.

40690 Statistical properties of the ^{235}U resonance parameters up to 300 eV. Leal, L.C.; de Saussure, G.; Winters, R.R.; Perez, R.B. *Transactions of the American Nuclear Society (USA),* 59: 341-342 (1989). (CONF-890604–: Annual meeting of the American Nuclear Society, Atlanta, GA (USA), 4-8 Jun 1989).

An accurate resonance analysis of the ^{235}U neutron cross sections up to 300 eV is in progress for the ENDF/B-VI files. A detailed discussion of the data base and a description of the method of resonance analysis have been given elsewhere. The purpose of this paper is to report on the statistical properties of the ^{235}U resonance parameters and compare our results with those of previous analyses. The statistical properties of nuclear levels are of both technical and theoretical interest. From the technical viewpoint, these properties are the basis for an extrapolation into the unresolved resonance region, which is of relevance to the calculation of effective group cross sections for reactor design. From the theoretical viewpoint, the resonance parameters obtained from a multilevel R-matrix analysis of a consistent set of neutron cross sections should satisfy a set of statistical properties arising from general properties of the nuclear Hamiltonian.

40691 New evaluated kerma factor library from ENDF/B-V data. Farawila, Y.M.; Maynard, C.W. *Transactions of the American Nuclear Society (USA),* 59: 342-343 (1989). (CONF-890604–: Annual meeting of the American Nuclear Society, Atlanta, GA (USA), 4-8 Jun 1989).

The problem addressed in this paper is the accurate evaluation of neutron fluence-to-kerma (kinetic energy released in materials) factors from microscopic nuclear data. Accurate kerma factors are necessary for calculating the local heat generation in materials subject to neutron irradiation, such as shields and fusion reactor blankets. The new algorithms developed for this purpose combine in a consistent manner the two basic methods for computing kerma factors, namely, reaction kinematics and direct energy balance. These algorithms are implemented in the code KAOS-V (kerma and other stuff), which was used as the main evaluating tool to construct the nuclear response function library KAOS/LIB-V.

40692 Impact of ^{235}U (MAT 9235) evaluation on k_{eff} of thermal systems. Wright, R.Q.; Williams, M.L.; Slater, C.O. *Transactions of the American Nuclear Society (USA),* 59: 343-344 (1989). (CONF-890604–: Annual meeting of the American Nuclear Society, Atlanta, GA (USA), 4-8 Jun 1989).

A new evaluation of the ^{235}U neutron cross sections in the resolved resonance region is being done for ENDF/B-VI. Other changes are also planned, including a revised unresolved resonance range, thermal $\bar{\nu}$, and fission spectrum; the new evaluation is currently referred to as MAT 9235. There is considerable interest in the MAT 9235 evaluation because of the potential impact of the cross-section changes on K_{eff} of low-enriched and highly enriched uranium systems. Of particular interest is the change in ^{235}U η below 1.86 eV. Significant reduction in the uncertainty of ^{235}U η, which was given as $\pm$0.3% in 1975, has been achieved; e.g., Axton's evaluation is 2.0799 $\pm$ 0.17%.

40693 Variable dimensional core neutronics modeling. Beard, C.L.; Chao, Y.A. *Transactions of the American Nuclear Society (USA),* 59: 353-355 (1989). (CONF-890604–: Annual meeting of the American Nuclear Society, Atlanta, GA (USA), 4-8 Jun 1989).

It is often convenient and practically useful for a multidimensional neutronics code to have the capability of consistently modeling a core in one, two, and three dimensions. This requires a method of performing dimensional reduction of a three-dimensional core

model. Conventional methods, such as the use of transverse buckling, tend to be problem dependent and lack the generic applicability to nonreference core conditions. It would be appealing to have a more rigorous and generic method to implement variable dimensional core modeling. A superfast multidimensional nodal code, SPNOVA (SUPERRNOVA), has been developed recently at Westinghouse. The theory of SPNOVA has the additional advantage of being particularly suitable for variable dimensional core modeling. The SPNOVA code has the capability of easily creating consistent lower dimensional models that are demonstrated to be very accurate for appropriate applications. This variable dimensional capability unifies one-, two-, and three-dimensional modeling of a core. It allows a nuclear engineer to carry only a three-dimensional model for a core. From any of the three-dimensional cases, a fully compatible lower dimensional model can be generated, if so desired, to perform accurate and consistent lower dimensional analyses.

40694 Temperature distributions in well-insulated and closed/nearly closed-ended vertical pipes. Coffield, R.D.; Antaki, G.A. *Transactions of the American Nuclear Society (USA)*, 59: 361-362 (1989). (CONF-890604--: Annual meeting of the American Nuclear Society, Atlanta, GA (USA), 4-8 Jun 1989).

Many different sized auxiliary lines are tied into the primary heat transport system piping of nuclear reactors and other similar types of systems. Often these lines are valve closed so that the contained fluid is either stagnant or flowing at low velocity due to free convection or small amounts of leakage (across valves). The characterization of the axial temperature distributions in these lines is important because of potential structural consequences to the pipe. For example, in addition to being required for determining basic thermal expansion allowances in piping networks, it is needed relative to other considerations such as thermal fatigue, which could occur due to leakage attaining a different temperature than that of the trunk line that it flows into. As would be anticipated, conditions that result in larger fluid temperature differences at a particular network juncture generally result in the more severe structural impact (e.g., thermal stratification/striping assessments become necessary). The purpose of this paper was to characterize some of the major phenomena that needed to be considered relative to predicting the range of temperature variations that can be experienced in the piping. The major emphases of these discussions are on vertical pipe orientation (either up or down).

40695 Theoretical evaluation of currently used critical heat flux correlations. Ayed, R.; Bourteele, J.P. *Transactions of the American Nuclear Society (USA)*, 59: 363-365 (1989). (CONF-890604--: Annual meeting of the American Nuclear Society, Atlanta, GA (USA), 4-8 Jun 1989).

The ratio between the critical and the actual heat flux is a measure of the margin to the departure from nucleate boiling in nuclear reactors. This margin depends on the accuracy of the correlation used to evaluate the critical heat flux (CHF). The accuracy depends on the data scattering and the expression chosen for the correlation. The authors present the reasoning behind their recommended formula for the critical heat flux correlation.

40696 Identification of two-phase flow patterns in a nuclear reactor by the high-frequency contribution fraction. Wang, Y.W.; Pei, B.S.; King, C.H.; Lee, S.C. *Transactions of the American Nuclear Society (USA)*, 59: 364-365 (1989). (CONF-890604--: Annual meeting of the American Nuclear Society, Atlanta, GA (USA), 4-8 Jun 1989).

Recently, King et al. and Wang et al. analyzed the fluctuating characteristics of differential pressure and void fraction by the optimum modeling method and by spectral analysis, respectively. These two investigations presented some new concepts and deterministic criteria, which are based on purely empirical formulas, to identify two-phase flow patterns. These deterministic criteria on two-phase flow patterns' identification seem to show reasonable performance. In King's and Wang's studies, there are at least three problems that need further investigations for the applications to the nuclear reactor engineering field. These three problems are the following: 1. Is the response to a certain two-phase flow pattern, i.e., the fluctuating characteristics, of neutrons the same as that of differential pressure or void fraction? 2. Could those criteria developed from air/water flow be allowed to identify steam/water two-phase flow patterns? 3. Could those criteria be applied to identify two-phase flow patterns in rod bundles? In this paper, parts of the investigated results answer the first problem, and detailed comparisons with the previous work of the authors are given on a variety of items.

2202 Components and Accessories

Refer also to citation(s) 40397, 40648, 40792, 40793, 40802, 40812, 40818, 40819, 40822, 40826, 41006, 41495

40697 (ANL/PPRNT–90-211) **Droplet entrainment correlation in annular two-phase flow.** Ishii, Mamoru (Argonne National Lab., IL (USA)); Mishima, Kaichiro. Argonne National Lab., IL (USA). [1990]. 38p. Sponsored by Nuclear Regulatory Commission. DOE Contract W-31109-ENG-38. Available from OSTI.

The droplet entrainment from a liquid film by gas flow is important to mass, momentum, and energy transfer in annular two-phase flow. The amount of entrainment can significantly affect occurrences of the dryout and post-dryout heat flux as well as the rewetting phenomena of a hot dry surface. In view of these, a correlation for the amount of entrained liquid in annular flow has been developed from a simple model and experimental data. There are basically two different regions of entrainment, namely, the entrance and quasi-equilibrium regions. The correlation for the equilibrium region is expressed in terms of the dimensionless gas flux, diameter, and total liquid Reynolds number. The entrance effect is taken into account by an exponential relaxation function. It has been shown that this new model can satisfactorily correlate wide ranges of experimental data for water. Furthermore, the necessary distance for the development of entrainment is identified. These correlations, therefore, can supply accurate information on entrainment which have not been available previously. 37 refs., 14 figs.

40698 (EPRI-NP–6721-M) **Corrosion evaluation of thermally treated Alloy 600 tubing in primary and faulted secondary water environments: Final report.** Jacko, R.J. (Westinghouse Electric Corp., Pittsburgh, PA (USA)). Electric Power Research Inst., Palo Alto, CA (USA); Westinghouse Electric Corp., Pittsburgh, PA (USA). ©Jun 1990. 73p. Sponsored by Electric Power Research Institute. Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

The project compared the corrosion resistance of thermally treated (TT) Alloy 600 tubing with mill annealed (MA) tubing. In primary water, the TT extended the stress corrosion cracking (SCC) initiation time by at least 4 fold at 360° (680°F) and by greater than 10 fold in an accelerated 400°C (752°F) steam test. SCC initiation times in highly strained laboratory specimens indicated that SCC initiation followed a log-normal probability distribution with time. The variable SCC initiation time for MA tubing decreased with decreasing grain size,with decreasing intergranular carbide precipitation, increasing intragranular carbides and increasing cold work. SCC test were performed on C-ring specimens of Alloy 600 tubing in 1, 10 and 50 wt% NaOH solutions over the temperature range from 288 to 343°C (550 to 650°F). Both SCC initiation and growth were evaluated. For NaOH concentrations of 10% and less, and temperatures at or below 316°C, the TT both increased the initiation time and decreased the observed depth of SCC. The improvement associated with thermal treatment was approximately an order of magnitude. With increasing temperature and caustic concentration, the advantage of TT gradually diminished. The influence of several sludge constituents on the corrosion properties of Alloy 600 was examined in deaerated NaOH solutions.

40699 (KFKI–1989-61/G) **Cold leg leak analysis of the Paks Nuclear Power Plant: 3.5application.** Perneczky, L.; Toth, I.; Ezsoel, Gy.; Szabados, L. Hungarian Academy of Sciences, Budapest (Hungary). Central Research Inst. for Physics. Nov 1989. 47p. (In Hungarian). Order Number DE90634038. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Cold leg break simulation tests were performed in the PMK-NVH test facility for the research and analysis of LOCA processes for WWER-440 type reactors. Results of experiments with emergency

cooling system but without the use of hydroaccumulators (SITs) in operation are presented. Data were processed by computer calculations using RELAP4/mod6 code. Input data and physical models and interpretation of the results are summarized. (R.P.) 6 refs.; 3 figs.

40700 (NUREG/CR–5280-Vol.1) **Age-related degradation of Westinghouse 480-volt circuit breakers: Aging assessment and recommendations for improving breaker reliability: Volume 1.** Subudhi, M. (Brookhaven National Lab., Upton, NY (USA)); Shier, W.; MacDougall, E. Nuclear Regulatory Commission, Washington, DC (USA). Div. of Engineering; Brookhaven National Lab., Upton, NY (USA). Jul 1990. 88p. Sponsored by Nuclear Regulatory Commission. DOE Contract AC02-76CH00016. (BNL-NUREG–52178-Vol.1). Available from NTIS, PC A05/MF A01 - GPO; OSTI; INIS.

An aging assessment of Westinghouse DS-series low-voltage air circuit breakers was performed as part of the Nuclear Plant Aging Research (NPAR) program. The objectives of this study are to characterize age-related degradation within the breaker assembly and to identify maintenance practices to mitigate their effect. Since this study has been promulgated by the failures of the reactor trip breakers at the McGuire Nuclear Station in July 1987, results relating to the welds in the breaker pole lever welds are also discussed. The design and operation of DS-206 and DS-416 breakers were reviewed. Failure data from various national data bases were analyzed to identify the predominant failure modes, causes, and mechanisms. Additional operating experiences from one nuclear station and two industrial breaker-service companies were obtained to develop aging trends of various subcomponents. The responses of the utilities to the NRC Bulletin 88-01, which discusses the center pole lever welds, were analyzed to assess the final resolution of failures of welds in the reactor trips. Maintenance recommendations, made by the manufacturer to mitigate age-related degradation were reviewed, and recommendations for improving the monitoring of age-related degradation are discussed. As described in Volume 2 of this NUREG, the results from a test program to assess degradation in breaker parts through mechanical cycling are also included. The testing has characterized the cracking of center-pole lever welds, identified monitoring techniques to determine aging in breakers, and provided information to augment existing maintenance programs. Recommendations to improve breaker reliability using effective maintenance, testing, and inspection programs are suggested. 13 refs., 21 figs., 8 tabs.

40701 (ORNL/FTR–3641) **[Damage classification of concrete structures]: Foreign trip report, June 9–June 23, 1990.** Naus, D.J. Oak Ridge National Lab., TN (USA). 9 Jul 1990. 29p. Sponsored by Nuclear Regulatory Commission. DOE Contract AC05-84OR21400. Available from NTIS, PC A03/MF A01 - OSTI.

The traveler participated in the fourth meeting of RILEM TC-104, "Damage Classification of Concrete Structures." In addition, the traveler met with staff members of the Technical University of Munich, Basler & Hofmann Consulting Engineers, Danish Ministry of Transport, Taywood Engineering Ltd., British Cement Association, Building Research Establishment, and Nuclear Electric. The meetings pertained to damage classification of concrete structures, diagnostics, and aging of concrete materials and components. With increasing awareness of the degradation of concrete structures, the European research organizations have comprehensive research programs under way to address this issue. Information was provided of direct application to the Structural Aging Program, which would not have been available without these visits. Of equal, or possible more importance, was the individual contacts established at these organizations. Each organization expressed interest in the Structural Aging Program as well as establishing lines of communication for information exchange. The initial steps were taken to cooperate and this should help the Structural Aging Program keep abreast of related European activities. In summary, information obtained during this trip will benefit the ongoing Structural Aging Program by informing ORNL of the extensive European research programs addressing the durability of concrete structures, and also by forming and strengthening acquaintances with counterparts in other countries, thus enhancing the basis for possible international cooperation. 34 refs.

40702 A nuclear power plant system engineering workstation. Mason, J.H.; Crosby, J.W. *Transactions of the American Nuclear Society (USA)*, 59: 305-308 (1989). (CONF-890604–: Annual meeting of the American Nuclear Society, Atlanta, GA (USA), 4-8 Jun 1989).

System engineers offer an approach for effective technical support for operation and maintenance of nuclear power plants. System engineer groups are being set up by most utilities in the United States. Institute of Nuclear Power operations (INPO) and U.S. Nuclear Regulatory Commission (NRC) have endorsed the concept. The INPO Good Practice and a survey of system engineer programs in the southeastern United States provide descriptions of system engineering programs. The purpose of this paper is to describe a process for developing a design for a department-level information network of workstations for system engineering groups. The process includes the following: (1) application of a formal information engineering methodology, (2) analysis of system engineer functions and activities; (3) use of Electric Power Research Institute (EPRI) Plant Information Network (PIN) data; (4) application of the Information Engineering Workbench. The resulting design for this system engineer workstation can provide a reference for design of plant-specific systems.

40703 Dynamic compensation of the rhodium self-powered neutron detector. Yusuf, S.O.; Wehe, D.K. *Transactions of the American Nuclear Society (USA)*, 59: 336-337 (1989). (CONF-890604–: Annual meeting of the American Nuclear Society, Atlanta, GA (USA), 4-8 Jun 1989).

The rhodium self-powered neutron detector (RSPND) is a common detector used to map out flux profiles at both commercial power reactors and research reactors. Questions about the RSPND that still require more attention, however, concern its dynamics and spectral sensitivity. In this work, only the dynamic behavior is considered. Based on the decay constants of the activated rhodium, the length of time one should wait before 98% of the asymptotic signal change is achieved after a step change in the flux is >10 min. This response is too slow for transient analysis and for control purposes. In this work, the final value of the slowly changing output is predicted by two methods: (1) using an analog device that incorporates an inverse function amplifier to eliminate the undesirable slow response of the detector and (2) using an analyzer that is essentially a computer program that numerically solves the inverse kinetics equation for the flux as a function of time, given the initial flux, various sensitivity constants, and the current from an RSPND at all previous times.

2203 Fuel Elements

Refer also to citation(s) 40745, 40765, 40777, 40802

2204 Control Systems

40704 (IAE–4704-4) **NORD program: Processing of experimental data on the WWER-1000 power density fields.** Sarbukov, V.V.; Krajnov, Yu.A. Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow (USSR). Inst. Atomnoj Ehnergii. 1988. 48p. (In Russian). Order Number DE90634089. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

A procedure of estimating the state of the WWER-1000 core power density on the basic of the in-core instrumentation system data is presented. A NORD program realizing this procedure in BASIC has been developed for on-line processing of experimental data. The program is designed for operation in dialog mode, has a service input-output unit and a unit for statistical processing of experimental results. The program makes it possible to evaluate quantitatively the differences of the power density fields obtained on the basis of readings taken from temperature control detectors and detectors of the neutron measuring channels. 5 refs.; 3 tabs.

40705 (IAEA-TECDOC–542, pp. 129-144) **The TEX-I real-time expert system applied to situation assessment for the SNR-300 reactor.** Schmal, N. (Internationale Atomreaktorbau GmbH (INTERATOM), Bergisch Gladbach (Germany, F.R.)); Doerbecker, K.; Leder, H.J.; Rueckert, M.; Schade, H.J. International Atomic Energy Agency, Vienna (Austria). Feb 1990. Contract ITW

8503. (CONF-8810509–: Technical committee on use of expert systems in nuclear safety, Vienna (Australia), 17 Oct 1988). In *Use of expert systems in nuclear safety: Report of a technical committee meeting held in Vienna, 17-21 October 1988.* Order Number DE90631398. Available from NTIS (US Sales Only), PC A15/MF A01; OSTI; INIS.

Within the German TEX-I Project, sponsored by the Federal Ministry for Research and Technology, several companies applied technical expert systems for data interpretation, diagnosis and process control. Purpose of the diagnosis expert system reported here is to support the operators of the LMFBR SNR-300 in assessing plant status in real-time, based on readings from many sensors. By online connection to the process control computer, it can monitor all incoming signal values, check the consistency of data, continuously diagnose the current plant status, detect unusual trends prior to accidents, localize faulty components and recommend operators response in abnormal conditions. The systems architecture consists of two basic subsystems, an inference engine and an intelligent process interface, implemented in Lisp on a Symbolics-Workstation. The inference engine has been derived from BABYLON, a hybrid shell developed by the German computer research institute GMD. This shell includes rules, prologue, constraints and an object oriented frame processor. The extended version has a component description language and a top-down diagnosis scheme including a mechanism of attention focusing. Inference run as independent, quasi-parallel processes. These so-called inference tasks can interrupt or abort each other, if higher priority events must be processed. The complete system is modelled in an object oriented matter and is divided into several subsystems and each subsystem into its physical components. At present the expert system is connected to a real-time simulation of the reactor. The simulation is based on a thermohydraulic code for simulation of the transient behaviour of temperatures and flow rates in the reactor core, plena, pipes, pumps, valves, intermediate heat exchangers and cooling components. Additionally, the systems response to an asynchronous operator interaction can be simulated. (Abstract Truncated)

40706 (IWGFR–71) **Specialists' meeting on advanced controls for fast reactors, Argonne, Illinois, USA June 20-22, 1989.** International Atomic Energy Agency, Vienna (Austria). International Working Group on Fast Reactors. 1989. 375p. (CONF-890673–: IWGFR specialists meeting on advanced controls for fast reactors, Argonne, IL (USA), 20-22 Jun 1989). Order Number DE90634050. Available from NTIS (US Sales Only), PC A16/MF A01; OSTI; INIS.

The Specialists' Meeting on "Advanced Controls for Fast Reactors" was held in Argonne, Illinois, USA, from June 20 to 22, 1989. The meeting was sponsored by the International Atomic Energy Agency on the recommendation of the IAEA International Working Group on Fast Reactors and was hosted by Argonne National Laboratory and the US Department of Energy. It was attended by 20 participants and observers from Argentina, France, Germany, Japan, India, the USSR, the United Kingdom, the United States of America, and the IAEA. The purpose of the meeting was to provide an opportunity for participating countries to review and discuss their views on design and technology for advanced control in fast reactors. During the meeting papers were presented by the participants on behalf of their countries and organizations. Presentations were followed by open discussions on the subjects covered by the papers and summaries of the discussions were drafted. After the formal sessions were completed, a final discussion session was held and summaries, general conclusions and recommendations were approved by consensus. A separate abstract was prepared for each of the 22 papers presented at this meeting. Refs, figs, tabs, diagrams and photos.

40707 (IWGFR–71, pp. 2.12-2.17) **Advanced controls for fast reactors: The Argentine perspective.** Rovere, L.A. (Comision Nacional de Energia Atomica, San Carlos de Bariloche (Argentina). Centro Atomico Bariloche); Gho, C.J. International Atomic Energy Agency, Vienna (Austria). International Working Group on Fast Reactors. 1989. (CONF-890673–: IWGFR specialists meeting on advanced controls for fast reactors, Argonne, IL (USA), 20-22 Jun 1989). In *Specialists' meeting on advanced controls for fast reactors, Argonne, Illinois, USA June 20-22, 1989.* Order Number DE90634050. Available from NTIS (US Sales Only), PC A16/MF A01; OSTI; INIS.

Brazil and Argentina have started a joint program in the area of fast reactors in 1989. One of the objectives of this program is to design and construct an Experimental Fast Reactor (EFR), of approximately 50 MWth. The conceptual design of this reactor is expected to be completed by 1995. During the first stage of the program, Argentina will support the design and construction of a Fast Critical Facility (FCF) with expected start-up by the end of 1995. The control system to be developed for this "zero" power reactor is intended to include state-of-the-art features of interest to future commercial power reactors. A brief description of these features is presented. (author). 1 ref.

40708 (IWGFR–71, pp. 2.18-2.28) **Advanced operator's aids and control for French FBR's: Present and future.** Papin, B. (CEA Centre d'Etudes Nucleaires de Cadarache, 13 - Saint-Paul-lez-Durance (France). Inst. de Recherche Technologique et de Developpement Industriel (IRDI)); Voitellier, J. International Atomic Energy Agency, Vienna (Austria). International Working Group on Fast Reactors. 1989. (CONF-890673–: IWGFR specialists meeting on advanced controls for fast reactors, Argonne, IL (USA), 20-22 Jun 1989). In *Specialists' meeting on advanced controls for fast reactors, Argonne, Illinois, USA June 20-22, 1989.* Order Number DE90634050. Available from NTIS (US Sales Only), PC A16/MF A01; OSTI; INIS.

The European reactor SUPER-PHENIX (SPX 1) is at the present time the largest Fast Breeder Reactor in operation in the world. Its instrumentation and control systems have been designed more than a decade ago, but they are still at the leading edge of technology, while an extensive use of computerized systems is made, even in the reactor protection domain. The most important challenge for the utility is now to operate this power plant industrially and to prove the effectiveness of the technological solutions that have been chosen. In this context, advanced control systems and operator aids are not a major concern, at least for the present time. For longer-termed applications, developments concerning advanced controls are not reactor specific and this paper briefly presents an overview of French research programs, essentially in the light water reactors domain that could find some openings on the Fast Breeders. (author). 10 refs, 7 figs.

40709 (IWGFR–71, pp. 2.100-2.118) **Automated start-up of EBR-II: A preview.** Kisner, R.A. (Oak Ridge National Lab., Oak Ridge, TN (USA). Instrumentation and Controls Div.). International Atomic Energy Agency, Vienna (Austria). International Working Group on Fast Reactors. 1989. Contract DE-AC05-84OR21400. (CONF-890673–: IWGFR specialists meeting on advanced controls for fast reactors, Argonne, IL (USA), 20-22 Jun 1989). In *Specialists' meeting on advanced controls for fast reactors, Argonne, Illinois, USA June 20-22, 1989.* Order Number DE90634050. Available from NTIS (US Sales Only), PC A16/MF A01; OSTI; INIS.

Oak Ridge National Laboratory (ORNL) and Argonne National Laboratory (ANL) are undertaking a joint project to develop control philosophies, strategies, and algorithms for computer control of the start-up mode of the Experimental Breeder Reactor II (EBR-II). The major objective of this project is to show that advanced liquid-metal reactor (LMR) plants can be operated from low power to full power using computer control. Development of an automated control system with this objective in view will help resolve specific issues and provide proof through demonstration that automatic control for plant start-up is feasible. This paper describes the approach that will be used to develop such a system and some of the features it is expected to have. Structured, rule-based methods, which will provide start-up capability from a variety of initial plant conditions and degrees of equipment operability, will be used for accomplishing mode changes during plant start-up. Several innovative features will be incorporated such as signal, command, and strategy validation to maximize reliability, flexibility to accommodate a wide range of plant conditions, and overall utility. Continuous control design will utilize figures of merit to evaluate how well the controller meets the mission requirements. The operator interface will have unique "look ahead" features to let the operator see what will happen next. (author). 15 refs, 7 figs, 1 tab.

40710 (IWGFR–71, pp. 2.119-2.137) **Evaluating human knowledge and the knowledge assessment method (KAM).** Lockett, J.A. (UKAEA Atomic Energy Establishment, Winfrith (UK). Safety and Engineering Science Div.). International Atomic Energy Agency, Vienna (Austria). International Working Group on Fast Reactors. 1989. (CONF-890673–: IWGFR specialists meeting on advanced controls for fast reactors, Argonne, IL (USA), 20-22 Jun 1989). In *Specialists' meeting on advanced controls for fast reactors, Argonne, Illinois, USA June 20-22, 1989.* Order Number DE90634050. Available from NTIS (US Sales Only), PC A16/MF A01; OSTI; INIS.

Under normal circumstances, operating decisions are made in accordance with the operators understanding of written procedures and of the plant which they are controlling. To ensure plant safety, an operator must have sufficient knowledge to respond correctly when both routine and unusual events place demands on his knowledge and understanding of the plant and procedures. In order that plant operating procedures or the methods used in qualifying operators may be improved a quantitative measure of understanding is required. This paper proposes a methodology which could be developed to yield a quantitative assessment of an individual's understanding. An extension is outlined where the knowledge relevant at each stage of a progressing task is assessed. This is intended to allow the identification of those parts of a task which are only weakly supported by an operator's background knowledge and where for example additional training and/or improved documentation could be introduced to greatest effect. (author). 12 refs, 4 figs.

40711 (IWGFR–71, pp. 2.138-2.160) **Advanced monitoring and control systems for fast reactors.** Kazachkov, V.I. (Central Scientific Research Inst. of Complex Automation, Moscow (USSR)); Petrenko, A.A. International Atomic Energy Agency, Vienna (Austria). International Working Group on Fast Reactors. 1989. (CONF-890673–: IWGFR specialists meeting on advanced controls for fast reactors, Argonne, IL (USA), 20-22 Jun 1989). In *Specialists' meeting on advanced controls for fast reactors, Argonne, Illinois, USA June 20-22, 1989.* Order Number DE90634050. Available from NTIS (US Sales Only), PC A16/MF A01; OSTI; INIS.

One of the important aspects of nuclear power station (NPS) improvement with fast reactors is provision of safety. The safety conception of advanced fast power reactors is directed on elaborating such solutions where as much as possible properties of reactor self-protection and natural laws are used in which the self-protection of the nuclear reactor is realized. To these solutions we may refer the usage of hydraulically weighted rods of alarm protection, negative temperature and power coefficients, negative sodium empty effect, natural circulation without power sources, natural convection and other measures. Additionally special technological systems are envisaged, which start functioning with the coming of the initial event of the accident. 1 ref., 7 figs, 1 tab.

40712 (IWGFR–71, pp. 2.161-2.176) **The design and validation of advanced operator support systems for a role in plant safety.** Hughes, G. (Central Electricity Generating Board, Berkeley (UK). Berkeley Nuclear Labs.). International Atomic Energy Agency, Vienna (Austria). International Working Group on Fast Reactors. 1989. (CONF-890673–: IWGFR specialists meeting on advanced controls for fast reactors, Argonne, IL (USA), 20-22 Jun 1989). In *Specialists' meeting on advanced controls for fast reactors, Argonne, Illinois, USA June 20-22, 1989.* Order Number DE90634050. Available from NTIS (US Sales Only), PC A16/MF A01; OSTI; INIS.

Advanced operator support systems have the potential of making a significant contribution to plant safety. This note reviews the different support functions required, the specification of performance criteria and possible approaches for system validation. The importance of the different functions that can be provided is related to the stage of the accident sequence. Also, because of the restricted reliability of any single system, subdivision of the systems is suggested in order to make the maximum contribution at a number of sequential stages. In this way it should be possible to make a significant claim for reduced operator error over the full accident progression, from incipient fault to disaster. The use of performance criteria currently associated with the classification of safety-grade trip systems (e.g. detection failure probability) would seem to provide a sound basis for validation. The validation of systems is seen as a significant task which will rely on the use of design and training-simulator data together with specific plant measurements. Expert systems appear to present particular problems for validation. (author). 9 refs, 5 figs, 1 tab.

40713 (IWGFR–71, pp. 2.177-2.189) **Programmable electronic systems in fast reactor safety in the UK.** Smith, I.C. (UKAEA Atomic Energy Establishment, Winfrith (UK). Safety and Engineering Science Div.); Wall, D.N. International Atomic Energy Agency, Vienna (Austria). International Working Group on Fast Reactors. 1989. (CONF-890673–: IWGFR specialists meeting on advanced controls for fast reactors, Argonne, IL (USA), 20-22 Jun 1989). In *Specialists' meeting on advanced controls for fast reactors, Argonne, Illinois, USA June 20-22, 1989.* Order Number DE90634050. Available from NTIS (US Sales Only), PC A16/MF A01; OSTI; INIS.

Programmable electronic systems are not currently used in the UK as part of reactor protection systems, hardwired logic protection being used. The UK has, however, an interest in such systems and conducted research into the use of microelectronics as part of reactor protection systems. This work has led to the development of the ISAT (Individual Subassembly Temperature monitor) which is currently operating in a passive mode on PFR (Prototype Fast Reactor). The advantages of this and similar systems are discussed and some of the difficulties in ensuring software quality and, where appropriate, diversity are considered, particularly in the context of licensing. Some considerations on the possible developments of this system and approach to safety are reported. (author). 3 figs.

40714 (IWGFR–71, pp. 2.190-2.209) **LMR design to facilitate control.** Planchon, H.P. (Argonne National Lab., IL (USA)); Golden, G.H.; Sackett, J.I.; Singer, R.M.; Mohr, D.; Chang, L.K.; Vilim, R.B.; Feldman, E.E. International Atomic Energy Agency, Vienna (Austria). International Working Group on Fast Reactors. 1989. Contract W-31-109-Eng-38. (CONF-890673–: IWGFR specialists meeting on advanced controls for fast reactors, Argonne, IL (USA), 20-22 Jun 1989). In *Specialists' meeting on advanced controls for fast reactors, Argonne, Illinois, USA June 20-22, 1989.* Order Number DE90634050. Available from NTIS (US Sales Only), PC A16/MF A01; OSTI; INIS.

The opportunities for improvement of reactor controls are generally in two areas. First the complexity of safety systems (which evolves from the philosophy of safety reliability through redundancy, diversity and independence) can be reduced. The reliability and diverse nature of passive shutdown, convective heat removal and hydrostatic mitigation of leaks in the primary boundary allow considerable simplification or deletion of active control and protection system, while at the same time improving reliability of the safety functions. Second, the operability of reactors may be improved by emphasizing passive response. If inherent safety features can be made to be an outer bound to a control system, then there will be more freedom to innovate and improve plant control with advanced diagnostics and control methods. We in EBR-II first identified constraints on control system design for inherent safety while doing the safety analysis for the inherent safety demonstration tests. Tests conducted in November 1987 showed several possibilities for controlling the plant with minimum control rods. Further tests are planned to investigate these alternate control system designs and identify issues and tradeoffs in inherent safety, complexity, and plant operability. The balance of this paper is thus divided into three sections, passive safety considerations and a summary of the earlier test results, the origin of focus on control and supporting tests in EBR-II, and future tests. 10 refs, 4 figs.

40715 (IWGFR–71, pp. 2.29-2.41) **Control system design of Indian prototype fast breeder reactor (PFBR).** Raghavan, K. (Indira Gandhi Centre for Atomic Research, Kalpakkam (India)). International Atomic Energy Agency, Vienna (Austria). International Working Group on Fast Reactors. 1989. (CONF-890673–: IWGFR specialists meeting on advanced controls for fast reactors, Argonne, IL (USA), 20-22 Jun 1989). In *Specialists' meeting on advanced controls for fast reactors, Argonne, Illinois, USA June 20-22, 1989.* Order Number DE90634050. Available from NTIS (US Sales Only), PC A16/MF A01; OSTI; INIS.

Indian nuclear power programme envisages setting up a series of commercial fast breeder power plants in the early half of next century. A 40 MW thermal (13.2 MWe) Fast Breeder Test Reactor has been set up and a 500 MW(e) Prototype Fast Breeder Reactor is under design. So far all the nuclear power plants in India have been using only conventional hard wired instrumentation and control systems. Computers have been mainly used as data loggers. A beginning has been made in the use of computers in India's first Fast Breeder Test Reactor, commissioned recently, for on-line core supervision, in addition to data logging function. With the great advancement in digital distributed control systems world over, it is planned to use microprocessors, programmable controllers and central computers for the control systems of PFBR. In this presentation the approach to be followed in the architecture of such control systems in PFBR is outlined. Use of these systems for safety functions is approached with caution. Critical parameters will be segregated from less important ones for treatment. Arrangement of plant main control room and emergency control room in enhancing efficiency of operator functioning is given due importance. Graphic displays for alarm annunciation, trend display and incident analysis will be extensively used. Multiplexing information between local control stations and control room will be resorted to for non-safety systems. Redundancy in system configuration, self diagnostic features, fault tolerant design and signal validation techniques are planned for increasing system reliability and hence plant availability. (author). 1 fig., 2 tabs.

40716 (IWGFR–71, pp. 2.210-2.219) **Supervisory control in a distributed, hierarchical architecture for a multimodular LMR.** Otaduy, P.J. (Oak Ridge National Lab., TN (USA)); Brittain, C.R.; Rovere, L.A. International Atomic Energy Agency, Vienna (Austria). International Working Group on Fast Reactors. 1989. Contract DE-AC05-84OR21400. (CONF-890673–: IWGFR specialists meeting on advanced controls for fast reactors, Argonne, IL (USA), 20-22 Jun 1989). In *Specialists' meeting on advanced controls for fast reactors, Argonne, Illinois, USA June 20-22, 1989.* Order Number DE90634050. Available from NTIS (US Sales Only), PC A16/MF A01; OSTI; INIS.

This paper describes the directions and present status of the research in supervisory control for multimodular nuclear plants being conducted at Oak Ridge National Laboratory (ORNL) as part of U.S. Department of Energy's (DOE) Advanced Controls Program. First, the hierarchical supervisory control structure envisioned for a Power Reactor Inherently Safe Module (PRISM) multimodular LMR is discussed. Next, the architecture of the supervisory module closest to the process actuators and its implementation for demonstration in a network of CPU's are presented. (author). 12 refs, 3 figs.

40717 (IWGFR–71, pp. 2.220-2.242) **A formal net specification of the communication in a distributed fast reactor diagnostic system.** Eggert, H. (Kernforschungszentrum Karlsruhe GmbH (Germany, F.R.). Inst. fuer Datenverarbeitung in der Technik). International Atomic Energy Agency, Vienna (Austria). International Working Group on Fast Reactors. 1989. (CONF-890673–: IWGFR specialists meeting on advanced controls for fast reactors, Argonne, IL (USA), 20-22 Jun 1989). In *Specialists' meeting on advanced controls for fast reactors, Argonne, Illinois, USA June 20-22, 1989.* Order Number DE90634050. Available from NTIS (US Sales Only), PC A16/MF A01; OSTI; INIS.

The Petri Net Theory provides a method for the formal specification of concurrent systems (e.g. distributed computer systems for diagnostic and shutdown functions in Fast Reactors). This method includes the verification/validation of the net specification about the causal behavior of the modeled concurrent system. Especially the Predicate/Transition Nets (most important class of high level nets) provide very compact net specifications. Additionally, a Predicate/Transition Net can be described by different levels of a system abstraction (for example in form of a net morphism). So it is possible to describe a concurrent system in a formal manner and to validate its causal behavior already during the design phase in the software live cycle. For example it can be shown, that all global states of an application protocol do not include deadlocks and livelocks. Formal net specifications and the results of their analysis raise the reliability of software systems themselves and also the quality of the software documentation. For the verification and documentation of net specifications computer tools are an absolute necessity. In our case the operating system UNIX is available with a special Petri Net Tool PROVER (PRedicate/Transition Net Oriented VERification System). In this environment a net specification was developed which provides a formal description of an application protocol for a communication system. This communication system is the central part of our distributed Fast Reactor Diagnostic System DESYRE (Diagnostic Expert SYstem for REactor Surveillance). (author). 16 refs, 20 figs.

40718 (IWGFR–71, pp. 2.243-2.254) **A knowledge based on-line diagnostic system for the fast breeder reactor KNKII.** Eggert, H. (Kernforschungszentrum Karlsruhe GmbH (Germany, F.R.). Inst. fuer Datenverarbeitung in der Technik); Scherer, K.P.; Stiller, P. International Atomic Energy Agency, Vienna (Austria). International Working Group on Fast Reactors. 1989. (CONF-890673–: IWGFR specialists meeting on advanced controls for fast reactors, Argonne, IL (USA), 20-22 Jun 1989). In *Specialists' meeting on advanced controls for fast reactors, Argonne, Illinois, USA June 20-22, 1989.* Order Number DE90634050. Available from NTIS (US Sales Only), PC A16/MF A01; OSTI; INIS.

In the nuclear research center at Karlsruhe, a diagnostic expert system is developed to supervise a fast breeder process (KNKII). The problem is to detect critical phases in the beginning state before fault propagation. The expert system itself is integrated in a computer network (realized by a local area network), where different computers are involved as special detection systems (for example acoustic noise, temperature noise, covergas monitoring and so on), which produce partial diagnoses, based on intelligent signal processing techniques like pattern recognition. Additional to the detection systems a process computer is integrated as well as a test computer, which simulates hypothetical and real fault data. On the logical top level the expert system manages the partial diagnoses of the detection systems with the operating data of the process computer and to produce a final diagnosis including the explanation part for operator support. The knowledge base is developed by typical Artificial Intelligence tools. Both fact based and rule based knowledge representations are stored in form of flavors and predications. The inference engine operates on a rule based approach. Specific detail knowledge, based on experience about any years, is available to influence the decision process by increasing or decreasing of the generated hypotheses. In a meta knowledge base, a rule master triggers the special domain experts and contributes the tasks to the specific rule complexes. Such a system management guarantees a problem solving strategy, which operates event triggered and situation specific in a local inference domain. (author). 3 refs, 6 figs, 2 tabs.

40719 (IWGFR–71, pp. 2.255-2.264) **Monitoring and control of nuclear steam generating plants including fast reactors.** Drumov, V.V.; Gorbunov, V.S.; Vostokov, V.S.; Krytjev, I.S. International Atomic Energy Agency, Vienna (Austria). International Working Group on Fast Reactors. 1989. (CONF-890673–: IWGFR specialists meeting on advanced controls for fast reactors, Argonne, IL (USA), 20-22 Jun 1989). In *Specialists' meeting on advanced controls for fast reactors, Argonne, Illinois, USA June 20-22, 1989.* Order Number DE90634050. Available from NTIS (US Sales Only), PC A16/MF A01; OSTI; INIS.

The main attention is paid to one aspect of the computerized systems' creation problem, namely, to the development of specific system's functions concerning monitoring and control. That is, first of all, the regimes' optimization aimed at reducing equipment damageability, at improvement of safety. The possibility is considered for improvement of neutron flux monitoring during refuelling aimed at control rod movements' detection, as well as possibility of lowering thermal stresses when realizing the protection in the regimes with violation of normal operating conditions including the loop isolation. The possibility and purposefulness of using computer systems for this task as well as for control of the plant residual heat removal system, for the plant startup and shutdown are considered. The developments are mentioned concerning the operator's advisor system as well as questions of the system's distributiveness. (author). 3 figs.

40720 (IWGFR–71, pp. 2.265-2.275) **Remote measurement of LMFBR fuel assembly outlet temperature by ultrasonics.** Monday, C.H.; Macleod, I.D.; Hughes, G. International Atomic Energy Agency, Vienna (Austria). International Working Group on Fast Reactors. 1989. (CONF-890673–: IWGFR specialists meeting on advanced controls for fast reactors, Argonne, IL (USA), 20-22 Jun 1989). In *Specialists' meeting on advanced controls for fast reactors, Argonne, Illinois, USA June 20-22, 1989.* Order Number DE90634050. Available from NTIS (US Sales Only), PC A16/MF A01; OSTI; INIS.

The paper outlines work which has been performed as part of a joint R and D programme (UKAEA, NNC and CEGB) to develop a remote method capable of measuring core and breeder subassembly outlet temperatures. The technique depends on measuring the transit time of an ultrasonic pulse across the top of a subassembly and using this to calculate the velocity of sound which in sodium is a linearly decreasing function of temperature over the range of interest. Since the method is very fast (several hundred measurements per second are possible) it can also be used to measure rapid temperature fluctuations, temperature noise, which has been shown to be a promising method of detecting internal overheating in a subassembly at an early stage. (author). 2 refs, 11 diagrams.

40721 (IWGFR–71, pp. 2.276-2.283) **The system of sodium boiling monitoring in the fast nuclear reactor core.** Nikiforov, B.N.; Petrenko, A.A.; Schekotov, V.G. International Atomic Energy Agency, Vienna (Austria). International Working Group on Fast Reactors. 1989. (CONF-890673–: IWGFR specialists meeting on advanced controls for fast reactors, Argonne, IL (USA), 20-22 Jun 1989). In *Specialists' meeting on advanced controls for fast reactors, Argonne, Illinois, USA June 20-22, 1989.* Order Number DE90634050. Available from NTIS (US Sales Only), PC A16/MF A01; OSTI; INIS.

Two accidents are considered independently by USSR regulatory documents as maximum project accident (MPA) at nuclear power stations with fast reactors: pipe-line sealfailure of the first loop, which has no protective housing; contraction or blocking of the flow area in separate fuel assemblies (FA) due to swelling up, sedimentation of impurities from the coolant or due to ingress of foreign bodies, that leads to the coolant flow-rate decrease through this FA as well as to the damage, destruction or fusion of fuel elements in it with an extension of damages at one row of surrounding fuel assemblies. The considered system is intended for the monitoring of processes, which are associated with the second MPA accident. The initial stage of heat removal decline is accompanied by local sodium overheat and boiling. Possible result consists in the overgrowing of one fuel assembly local overheat and fusion into the whole core overheat and fusion. The task is to detect local overheat early and to prevent its overgrowing into the whole core overheat and fusion. For a number of years investigations have been carried out in the USSR on various methods of sodium boiling monitoring. The final aim of these investigations is working out the criteria, which determine the dangerous stage of the sodium boiling process in order to automate protective actions which exclude core fusion. The developed system of sodium boiling monitoring is intended for fast-neutron power reactors, which are being built now. 1 ref., 3 figs.

40722 (IWGFR–71, pp. 2.284-2.291) **New automated control and protection system of the fast-neutron power reactor core.** Yephimov, I.A.; Mamayev, L.I.; Filonov, V.S.; Ushakov, V.M. International Atomic Energy Agency, Vienna (Austria). International Working Group on Fast Reactors. 1989. (CONF-890673–: IWGFR specialists meeting on advanced controls for fast reactors, Argonne, IL (USA), 20-22 Jun 1989). In *Specialists' meeting on advanced controls for fast reactors, Argonne, Illinois, USA June 20-22, 1989.* Order Number DE90634050. Available from NTIS (US Sales Only), PC A16/MF A01; OSTI; INIS.

Control and protection system of the reactor core is the most important part of automated control process systems. In the Soviet Union safety requirements are determined by Nuclear Safety Rules and by Common Safety Statements. The new control and protection system of the fast-neutron power reactor core is intended for the most complete satisfaction of safety requirements. This is achieved by the system functions expansion, by increasing information quantity and reliability on the basis of wide usage of microprocessor facilities and modern computers. Automated system carries out the following functions: failed fuel detection (FFD); in-core temperature monitoring (ICTM); detection of defective assemblies (DDA); boiling monitoring on neutron and acoustic noises (BMNA); alarm signal shaping when the permissible equivalence of open fuel area is exceeded at each circulation loop of nuclear reactor; alarm signal shaping at sodium boiling; alarm signal shaping when permissible coolant temperature and temperature increase velocity are exceeded. 5 refs, 2 figs.

40723 (IWGFR–71, pp. 2.292-2.327) **Benchmark test on signal processing for boiling noise detection; analysis of data from BOR 60.** Rowley, R. (UKAEA Northern Research Labs., Risley (UK)); Waites, C.; Macleod, I.D. International Atomic Energy Agency, Vienna (Austria). International Working Group on Fast Reactors. 1989. (CONF-890673–: IWGFR specialists meeting on advanced controls for fast reactors, Argonne, IL (USA), 20-22 Jun 1989). In *Specialists' meeting on advanced controls for fast reactors, Argonne, Illinois, USA June 20-22, 1989.* Order Number DE90634050. Available from NTIS (US Sales Only), PC A16/MF A01; OSTI; INIS.

Data from boiling noise experiments in the BOR60 reactor in USSR has been supplied by the IAEA to enable analysis techniques to be compared. The signals have been analysed at RNL using two basic techniques. High Frequency RMS analysis Pulse Counting analysis together with two more sophisticated methods, Pattern Recognition and Pulse Timing analysis. All methods indicated boiling successfully, pulse counting proved more sensitive than RMS for the detection of the onset of boiling. Pattern Recognition shows promise of a very reliable detector provided the background can be defined. Data from an ionisation chamber was also supplied and there was good correlation between neutronic and acoustic signals. (author). 3 refs, 25 figs, 3 tabs.

40724 (IWGFR–71, pp. 2.328-2.341) **Towards an on-line expert system for clad failure management in fast reactors.** Lennox, T.A. (UKAEA, DNE (UK)). International Atomic Energy Agency, Vienna (Austria). International Working Group on Fast Reactors. 1989. (CONF-890673–: IWGFR specialists meeting on advanced controls for fast reactors, Argonne, IL (USA), 20-22 Jun 1989). In *Specialists' meeting on advanced controls for fast reactors, Argonne, Illinois, USA June 20-22, 1989.* Order Number DE90634050. Available from NTIS (US Sales Only), PC A16/MF A01; OSTI; INIS.

Experience of clad failures in fast reactors has increased over the last few years with a corresponding accumulation of information on the response of the reactor clad failure monitoring systems. The establishment of a clad failure database is proposed as a formal method for assessing this experience with the reactor instrumentation. The transfer of this formal experience to an on-line expert system for clad failure management is discussed with the objective of providing the reactor operators with an enhanced clad failure management system. (author). 15 refs, 3 figs, 2 tabs.

40725 (IWGFR–71, pp. 2.342-2.355) **Recent advances in control and diagnostics development and application.** Monson, L.R. (Argonne National Lab., Idaho Falls, ID (USA)); King, R.W.; Lindsay, R.W.; Staffon, J.D. International Atomic Energy Agency, Vienna (Austria). International Working Group on Fast Reactors. 1989. Contract W-31-109-Eng-38. (CONF-890673–: IWGFR specialists meeting on advanced controls for fast reactors, Argonne, IL (USA), 20-22 Jun 1989). In *Specialists' meeting on advanced controls for fast reactors, Argonne, Illinois, USA June 20-22, 1989.* Order Number DE90634050. Available from NTIS (US Sales Only), PC A16/MF A01; OSTI; INIS.

The power industry is undergoing rapid technological advances and cultural changes. Technologies are advancing and evolving so rapidly that the industry is hard pressed to keep up and take full advantage of the many developments now in progress. Recent advances in state-of-the-art computer technology are making in-roads in the form of advanced computer control, expert systems, on-line performance monitoring and diagnostics. Validation and verification schemes are being developed which provide increased confidence in the correctness and reliability of both computer hardware and

software. Our challenge in the nuclear community is to effectively apply these new technologies to improve the operation, safety, and reliability of our plants. This presentation discusses two areas of development that are essential to advanced control strategies: application of diagnostic systems to improve fault-tolerance, and model-based graphic displays. 4 refs, 4 figs.

40726 (IWGFR–71, pp. 2.42-2.72) **Overview of the US program of controls for advanced reactors.** White, J.D. (Oak Ridge National Lab., TN (USA)); Sackett, J.I.; Monson, L.R.; Lindsay, R.W.; Carroll, D.G. International Atomic Energy Agency, Vienna (Austria). International Working Group on Fast Reactors. 1989. Contract DE-AC05-84OR21400;Contract W-31-109-Eng-38. (CONF-890673–: IWGFR specialists meeting on advanced controls for fast reactors, Argonne, IL (USA), 20-22 Jun 1989). In *Specialists' meeting on advanced controls for fast reactors, Argonne, Illinois, USA June 20-22, 1989.* Order Number DE90634050. Available from NTIS (US Sales Only), PC A16/MF A01; OSTI; INIS.

An automated control system can incorporate control goals and strategies, assessment of present and future plant status, diagnostic evaluation and maintenance planning, and signal and command validation. It has not been feasible to employ these capabilities in conventional hard-wired, analog, control systems. Recent advances in computer-based digital data acquisition systems, process controllers, fiber-optic signal transmission, artificial intelligence tools and methods, and small inexpensive, fast, large-capacity computers, with both numeric and symbolic capabilities, have provided many of the necessary ingredients for developing large, practical automated control systems. Furthermore, recent reactor designs which provide strong passive responses to operational upsets or accidents afford good opportunities to apply these advances in control technology. Under the sponsorship of the U.S. Department of Energy (DOE), work on advanced controls for advanced reactors is concentrated at the Oak Ridge National Laboratory (ORNL) in the Advanced Controls Program, at the EBR-II site by Argonne National Laboratory (ANL), and GE Nuclear Energy (GE) in design of the Power Reactor Inherently Safe Modular (PRISM) reactor. The DOE is also supporting considerable work at various universities. This paper presents an overall U.S. national perspective for advanced controls research and development. The goals of high reliability, low operating cost and simple operation are described. The staged approach from conceptualization through implementation is discussed. Then the paper describes briefly the work being done by ORNL, ANL and GE. The relationship of this work to the U.S. commercial industry is also discussed. 21 refs, 1 fig.

40727 (IWGFR–71, pp. 2.73-2.86) **A development program of self actuated shutdown system for liquid metal fast reactor.** Makoto Saito (Power Reactor and Nuclear Fuel Development Corp. (Japan)); Minoru Gunji; Mituru Kamei; Masahiko Sekiguchi; Tuyoshi Saito; Takasi Jodoi; Mineo Sekiguchi; Iwao Ikarimoto. International Atomic Energy Agency, Vienna (Austria). International Working Group on Fast Reactors. 1989. (CONF-890673–: IWGFR specialists meeting on advanced controls for fast reactors, Argonne, IL (USA), 20-22 Jun 1989). In *Specialists' meeting on advanced controls for fast reactors, Argonne, Illinois, USA June 20-22, 1989.* Order Number DE90634050. Available from NTIS (US Sales Only), PC A16/MF A01; OSTI; INIS.

Power Reactor and Nuclear Fuel Development Corporation (PNC) and Japan Atomic Power Company (JAPC, supported by the Japanese ten electric utility companies) are jointly developing the self actuating shutdown system (SASS) for liquid metal fast breeder reactors. A synthetic program was made and put into practice to investigate the feasibility of temperature sensitive electromagnet (TSEM) type self actuated shutdown system to the Demonstration Fast Breeder Reactor whose construction is expected to start in late 1990s. As of the end of 1988, fundamental function and properties of the system have been obtained, which suggest that the shutdown system with the TSEM would meet the severer safety requirement of fast reactors. Successive studies are under progress to examine the performance and availability of the system. A potential demonstration test of the SASS in actual reactor condition is being studied. (author). 4 refs, 9 figs, 2 tabs.

40728 (IWGFR–71, pp. 2.87-2.99) **Some experimental results and analysis on the temperature sensitive electromagnet: Self-welding between core and armature of the temperature sensitive electromagnet.** Makoto Saito (Power Reactor and Nuclear Fuel Development Corp., Oarai, Ibaraki (Japan). Oarai Engineering Center); Minoru Gunji; Koichirou Nakamoto. International Atomic Energy Agency, Vienna (Austria). International Working Group on Fast Reactors. 1989. (CONF-890673–: IWGFR specialists meeting on advanced controls for fast reactors, Argonne, IL (USA), 20-22 Jun 1989). In *Specialists' meeting on advanced controls for fast reactors, Argonne, Illinois, USA June 20-22, 1989.* Order Number DE90634050. Available from NTIS (US Sales Only), PC A16/MF A01; OSTI; INIS.

The self-welding phenomenon of the magnetic materials used for the core and the armature of the temperature sensitive electromagnet (TSEM) was taken up as the major problem to disturb the actuation of the TSEM, as the design temperature for the fast reactor was getting to be higher. Self-welding test was carried out in high temperature sodium, whose results strongly suggested that self-welding might occur under the operation condition expected in the demonstration fast reactor. A countermeasure against the self-welding between the core and the armature was proposed and the improved TSEM was put into examination. The results are going to be presented in this paper. (author). 1 ref., 8 figs, 2 tabs, 2 photos.

40729 (KFKI–1989-66/G) **Filtering technique for detection and identification of measurement failures in nuclear power plants.** Racz, A. Hungarian Academy of Sciences, Budapest (Hungary). Central Research Inst. for Physics. Nov 1989. 150p. (In Hungarian). Order Number DE90634073. Available from NTIS (US Sales Only), PC A07/MF A01; OSTI; INIS.

The basic requirement of the safe operation of nuclear power plants (NPP) is to have reliable information on all quantities that can be measured, monitored or controlled during the operation. Kalman filtering techniques have been applied for prompt detection and identification of failures in the measurement systems used in NPPs. Mathematical basis of Kalman filtering and various models applied to failure detection are overviewed. The applicability of some models are evaluated by real results of NPP measurements. A sample system for an NPP is suggested, based on several numerical tests. (R.P.) 23 refs.; 40 figs.; 2 tabs.

40730 (KIYI–88-42) **The theoretical and practical questions on modeling nuclear reactor kinetics.** Borisenko, V.I.; Golovach, A.I.; Grinevich, F.A.; Luk'yanets, V.V.; Sidoruk, N.M. AN Ukrainskoj SSR, Kiev (Ukrainian SSR). Inst. Yadernykh Issledovanij. 1989. 38p. (In Russian). Order Number DE90634074. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The development of rational methods of nuclear reactor state diagnostics is an important trend in a safaty control of NPP operation. The reactivity is the main indicator of nuclear reactor state. The reactivity determination is rather a complex problem, solved using analog and digital computers. The theoretical questions are discussed, related to mathematic model selection on the basis of which th device for reactivity determination so-called rectimeter is designed. A basic attention is paid to technical questions, related to the working-out and creation of the AIMR-8-2m an analog meter of instantaneous reactivity. The principle possibility of use of this device for determination of nuclear reactor global reactivity is shown. The expression for reactivity transition function in case of one-group approximation by delayed neutrons is obtained. The theoretical and practical questions on modeling of nuclear reactor kinetics. 10 refs.; 11 figs.

40731 (KIYI–88-43) **An investigation of serviceability of small-size thermoelectric neutron detectors in the conditions of the WWR-M reactor core.** Korotenko, M.N. (and others); Krasik, Yu.N.; Afanas'ev, P.G. AN Ukrainskoj SSR, Kiev (Ukrainian SSR). Inst. Yadernykh Issledovanij. 1989. 32p. (In Russian). Order Number DE90634075. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The results of the small-size thermoelectric neutron detectors (TND) with sensitive elements of boron steel and also uranium-nckel and uranium-palladium alloys with ^{235}U enrichment of 0.35-90% are given. The dependence of main metrological characteristics of TND on the density of the thermal neutron flux (in the

range of $5x10^{11}$-$5x10^{13}cm^{-2}xs^{-1}$), the neutron fluence (up to $1x10^{21}cm^{-2}$) and a number of structural factors is studied. It is shown that for the used detector modifications the sensitivity to thermal neutrons is $8x10^{-17}$-$3x10^{-15}Vcm^2xs$, the nonidentity- 1-10%, the time constant- 0.5-2.0 s. The measurement results are presented made at different experimental devices using TND, self-powered neutron detectors and activation detectors. An investigation of serviceability of small-size thermoelctric neutron detectors in the conditions of the WWR-M core. 12 refs.; 15 figs.; 5 tabs.

40732 (NUREG/CR–5374) **Summary of inadequate core cooling instrumentation for US nuclear power plants.** Anderson, J.L. (Oak Ridge National Lab., TN (USA)); Hagen, E.W.; Morelock, T.C. Nuclear Regulatory Commission, Washington, DC (USA). Div. of Systems Technology; Oak Ridge National Lab., TN (USA). Jul 1990. 182p. Sponsored by Nuclear Regulatory Commission. DOE Contract AC05-84OR21400. (ORNL/TM–11200). Available from NTIS, PC A09/MF A01 - GPO; OSTI; INIS.

Following the Three Mile Island Unit 2 accident in 1979, the US Nuclear Regulatory Commission (NRC) required significant improvements in instrumentation to detect and monitor recovery from inadequate core cooling (ICC). All pressurized water reactors (PWRs) ultimately were required to have redundant, qualified, Class 1E instrumentation for subcooling margin monitors, core exit thermocouples, and a reactor coolant inventory tracking system. The majority of PWR operators have adopted two generic designs developed by Westinghouse and Combustion Engineering and approved by NRC. Respectively, they are the differential pressure reactor vessel-level instrumentation system and the heated junction thermocouple system. These systems are evaluated in this report. Boiling water reactors (BWRs) were treated separately because of their different design features and because BWRs already use several d/p level-measurement systems for both control and safety functions. No new instrumentation was required for BWRs, but some upgrades and modifications were mandated to improve the reliability of the systems under accident conditions. These considerations for BWRs are evaluated in this report. This report documents the need for ICC instrumentation, the measurement concepts involved, and the reviews of PWR ICC instrumentation performance and components in redundancy, qualification, display, and implementation requirements detailed in NUREG-0737, Clarification of TMI Action Plan Requirements. Special considerations of the PWRs such as operator training and control room integration and display are also examined. Appended are sections of pertinent NRC regulatory guides and a chart of abnormal operating experiences involving reactor coolant levels.

40733 A concept of integrated control for nuclear power plants. Edwards, R.M.; Ray, A.; Schultz, M.A.; Kenney, E.S. *Transactions of the American Nuclear Society (USA),* 59: 290-291 (1989). (CONF-890604–: Annual meeting of the American Nuclear Society, Atlanta, GA (USA), 4-8 Jun 1989).

This paper presents a novel concept of integrated control of the diverse functions and spatially distributed system components in nuclear power plants. The goal is to develop an integrated system as a safe, economic, reliable, and flexible means for nuclear power generation by utilizing recent advances in microcomputer technology. An advanced light water reactor design concept is currently under development at Pennsylvania State University. The design concept is based on a reconfigured pressurized water reactor in which the conventional pressurizer is replaced by a modified injection letdown system. The design also accommodates station blackout by including emergency power generation from shutdown steam turbine generators until natural circulation in the rearranged plant is alone sufficient for long-term cooling. A salient feature of the ultra-safe research is to examine implementation of the nuclear power plant control system in a microcomputer-based control environment. A distributed control configuration can yield substantial improvements in the operation of future nuclear power plants. Such an integrated control system would have the potential to enhance maintainability, reliability, efficiency, and public acceptability and substantially alleviate the complexity of plant operations. Development of sophisticated applications software for powerful microprocessor-based controllers will facilitate the development of an integrated fault-tolerant control system.

40734 A customized digital monitoring and display system for nonpower reactors. Ficaro, E.P.; Wehe, D.K. *Transactions of the American Nuclear Society (USA),* 59: 324-325 (1989). (CONF-890604–: Annual meeting of the American Nuclear Society, Atlanta, GA (USA), 4-8 Jun 1989).

A digital data acquisition system for monitoring plant variables has been designed and implemented at the University of Michigan's Ford Nuclear Reactor (FNR), a 2-MW open-pool research reactor. The digital data provided by this system will be useful for: improved operator training, real-time experimental calculations, noise analysis, closed-loop control, and expert system applications. This paper describes the analog-to-digital (A/D) transitions and the associated applications and benefits experienced.

40735 Prospects for reactor reactivity control using lasers. Bowman, C.D. (Los Alamos National Lab., NM (USA)). *Transactions of the American Nuclear Society (USA),* 59: 340-341 (1989). (CONF-890604–: Annual meeting of the American Nuclear Society, Atlanta, GA (USA), 4-8 Jun 1989).

From the earliest days of reactor operation, mechanical motion of either an absorber or a reflector has been required for control of the reactor reaction rate. Recent developments in the polarization of substantial amounts of ^3He using laser light opens the possibility of reactor control by means of a laser without the motion of any mechanical components. The reactor is brought to power by shining laser light into a ^3He control tube (rod). It is fail-safe in the sense that disappearance of the laser light results in decay of the polarization, which reduces the criticality below one. Since the polarization can be destroyed in less than a millisecond without mechanical motion, rapid shutdown of reactivity is possible. The concept might therefore open up new possibilities for improvements in reactor safety and in the operating characteristics of special-purpose systems such as pulsed reactors.

2205 Environmental Aspects

Refer also to citation(s) 40809, 41534, 41588, 41597, 41620, 41621, 41622

40736 (HW–66023) **Final report on Production Test IP-233-I effect of water quality on effluent activity.** Hall, R.B.; Nesselson, E.J.; Pitman, R.W. General Electric Co., Richland, WA (USA). Hanford Atomic Products Operation. 11 Jul 1960. 29p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC06-76RL01830. Order Number DE90014019. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Declassified 16 October 1989.

This production test was performed to determine process water quality (turbidity) effects on reactor effluent activity, process tube and fuel jacket erosion-corrosion, process tube film formation, and ultimately the influence on capacity of existing filter plants. Process water effects were evaluated for turbidities by eliminating polyelectrolyte feed to the filters supplying the near side risers at 100-F Reactor. A two to three day run on single filters at 100-B, 100-D, and 100-DR Areas was used to calculated percent increases in filter capacity resulting from higher turbidity. 3 figs., 1 tab.

40737 (NUREG/CR–3444-Vol.7) **The impact of LWR decontaminations on solidification, waste disposal and associated occupational exposure: Volume 7.** Soo, P. (Brookhaven National Lab., Upton, NY (USA)); Milian, L.W. Nuclear Regulatory Commission, Washington, DC (USA). Div. of Engineering; Brookhaven National Lab., Upton, NY (USA). Jul 1990. 58p. Sponsored by Nuclear Regulatory Commission. DOE Contract AC02-76CH00016. (BNL-NUREG–51699-Vol.7). Available from NTIS, PC A04/MF A01 - GPO; OSTI; INIS.

Studies were carried out to investigate if simulated decontamination reagent/resin waste combinations could give rise to gas generation and thermal excursions during dewatering events. The results of temperature measurements and visual observations are given. In addition, the corrosion of various container materials by simulated decontamination resin waste was studied and the effects of gamma irradiation were quantified. Some limited work was also carried out to determine if gamma irradiation of ion exchange

resins causes structural changes and losses in ion-exchange capacity. 17 refs., 20 figs., 17 tabs.

40738 (WHC-EP–0165-1) **Westinghouse Hanford Company 100 Areas environmental releases for 1988.** Rokkan, D.J. Westinghouse Hanford Co., Richland, WA (USA). Mar 1990. 22p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC06-87RL10930. Order Number DE90013648. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

In 1988, there were no adverse trends observed from the routine radioactive and chemical discharges in the 100 Areas. Also, releases specifically from the N Reactor in the 100-N Area were within the technical specifications that limit operation of the plant. These releases were as expected, for the N Reactor has been shut down since January 7, 1987. The radiological and chemical releases in 1988 were generally less than those in 1987 due to the continued shutdown of the N Reactor. Initially this extended shutdown was ordered for upgrading of the reactor safety systems. However, N Reactor has remained shut down in "cold standby," due to the uncertain role it has in producing special nuclear materials. This document contains information on nonradioactive and radioactive substances released to the environment from Westinghouse Hanford Company facilities in the 100 Areas during calendar year 1988. 2 refs., 9 figs., 18 tabs.

2206 Research, Test, and Experimental Reactors

Refer also to citation(s) 40466, 40651, 40653, 40731, 40734, 40773, 40778, 40780, 40788, 40802, 40810, 41293, 41503

40739 (DOE/NP–0006P) **New Production Reactors Program: Report to the Congress by the Secretary of Energy.** USDOE Office of New Production Reactors, Washington, DC (USA). 1 Mar 1990. 44p. Sponsored by U.S. DOE Office of New Production Reactors. Order Number DE90013633. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

In August 1988, DOE issued a report to Congress announcing the Department's proposal for assuring future tritium production capacity through the building of new facilities, specifically, a preferred duality strategy that calls for the design and construction of a new, up-to-date heavy water reactor (HWR) at the Savannah River Site in South Carolina; and, at the same time, to proceed with the design and construction of a modular high-temperature gas-cooled reactor (MHTGR) plant to be located at the Idaho National Engineering Laboratory in Idaho. As a contingency, the Department is developing a light water reactor (LWR) tritium target for possible use in the partially completed WNP-1 reactor located on the Hanford Site, near Richland, Washington. The Secretary created the Office of New Production Reactors (NP) to accomplish the following mission: To provide new production reactor capacity on an urgent schedule for an assured supply of nuclear materials, primarily tritium, to maintain the Nation's nuclear deterrent capability. The organizational philosophy of the Program calls for strong central control with increased safety, environmental, and quality assurance oversight. In addition to separate Engineering Technology Offices for HWR, MHTGR, and LWR that will maintain technical control throughout the life of the Program, the NP Director has created oversight Offices for Safety and Quality and for Environment. An NP Project Management Office will be established at each of the three project sites with the Project Officer reporting directly to the Director of NP. Safety, Quality, and Environmental Field Representatives will be located on-site at the Project Management Offices to serve as a "resident" for the Headquarters' Office to whom they will report.

40740 (GKSS–89/E/57) **Compilation of backfitting measures for the FRG-1 and FRG-2 research reactors.** Krull, W. (GKSS-Forschungszentrum Geesthacht GmbH, Geesthacht-Tesperhude (Germany, F.R.). Zentralabteilung Forschungsreaktoren). GKSS-Forschungszentrum Geesthacht GmbH, Geesthacht-Tesperhude (Germany, F.R.). 1989. 38p. Order Number DE90510603. Available from NTIS (US Sales Only), PC A03/MF A01.

The efforts for the modernization of the FRG-reactors within the last two years and at present are: Measures against water leakage through the concrete and along beam tubes, repair of both cooling towers, modernization of the ventilation system, measures for fire protection, activities in water chemistry and water quality, installation of a double tubing for parts of the primary piping of the FRG-1, replacement of instrumentation, process control system (operation and monitoring system) and alarm system, installation of a cold neutron source, enrichment reduction for the FRG-1. Planned activities are: Renewal of the emergency power supply, installation for internal lightning protection, compressed air system. (orig.) With 26 figs., 1 tab.

40741 (HMI-B–479) **Moderator choice for the cold neutron source of the BER II.** Axmann, A.; Gobrecht, K. Hahn-Meitner-Institut Berlin GmbH (Germany, F.R.). Bereich Strukturforschung. Jul 1984. 30p. (In German). Order Number DE90510604. Available from NTIS (US Sales Only), PC A03/MF A01.

A Cold Neutron Source is foreseen in the modernization program of the Berlin Experimental Reactor BER II. The moderator will be hydrogen at 25 K. The phase and shape of the moderator, its neutron-physical and safety aspects are discussed in detail. (orig.).

40742 (JAERI-M–90-017) **Experimental test results of multi-channel test rig of T_1 test section, 2: Nonuniform power distribution test.** Hino, Ryutaro (Japan Atomic Energy Research Inst., Tokai, Ibaraki (Japan). Tokai Research Establishment); Takase, Kazuyuki; Miyamoto, Yoshiaki; Maruyama, Soh. Japan Atomic Energy Research Inst., Tokyo (Japan). Feb 1990. 62p. (In Japanese). Order Number DE90508035. Available from NTIS (US Sales Only), PC A04/MF A01.

Nonuniform power distribution test was performed with the multi-channel test rig of the fuel stack test section (T_1) in order to contribute the licensing of the JAERI's High-Temperature Engineering Test Reactor (HTTR). In the test, helium gas was heated up to 750degC under asymmetric and slantwise power distributions realized by changing input electric powers of 12 simulated fuel rods respectively. Experimental results showed that the distribution of helium gas flow rate was influenced by the temperature distortion in the mock-up fuel stack. Calculated results with the numerical thermal analysis code indicated that the temperature distortion in the fuel stack was flattened by the thermal conduction in the graphite block. (author).

40743 (JAERI-M–90-020) **Structural integrity of graphite core support structures of HTTR.** Inagaki, Yoshiyuki (Japan Atomic Energy Research Inst., Oarai, Ibaraki (Japan). Oarai Research Establishment); Iyoku, Tatsuo; Toyota, Junji; Sato, Sadao; Shiozawa, Shusaku. Japan Atomic Energy Research Inst., Tokyo (Japan). Feb 1990. 74p. (In Japanese). Order Number DE90508052. Available from NTIS (US Sales Only), PC A04/MF A01.

The graphite core support structures (GCSSs) of the HTTR (High Temperature Engineering Test Reactor) are an arrangement of graphite blocks and posts that support the core and provide a lower plenum and a hot-leg path for the primary coolant. The GCSSs are designed not to be replaced by new items during plant life time (about twenty years). To maintain structural integrity of the GCSSs, conservative design has been made sufficiently on the basis of structural tests. The present study confirmed that reactor safety was still maintained even if failure and destruction of the GCSSs is supposed to occur. The GCSSs are fabricated under strict quality control and the observation and surveillance programs are planed to examine the structual integrity of the GCSSs during an operation. This paper describes the concept of design and quality control and summarizes structural tests, observation and surveillance programs. (author).

40744 (JAERI-M–90-021) **COOLOD-N: a computer code, for the analyses of steady-state thermal-hydraulics in plate-type research reactors.** Kaminaga, Masanori (Japan Atomic Energy Research Inst., Tokai, Ibaraki (Japan). Tokai Research Establishment). Japan Atomic Energy Research Inst., Tokyo (Japan). Feb 1990. 67p. Order Number DE90508084. Available from NTIS (US Sales Only), PC A04/MF A01.

The COOLOD-N code provides a capability for the analysis of the steady-state thermal-hydraulics of research reactors in which plate-type fuel is employed. This code is revised version of the COOLOD code, and is applicable not only to a forced convection

cooling mode, but also to a natural convection cooling mode. In the code, a function to calculate flow rate under a natural convection, and a heat transfer package which was a subroutine program to calculate heat transfer coefficient, ONB temperature and DNB heat flux, and was especially developed for the upgraded JRR-3, have been newly added to the COOLOD code. The COOLOD-N code also has a capability of calculating the heat flux at onset of flow instability as well as DNB heat flux. (author).

40745 (JAERI-M–90-029) **Study on effect of hafnium disk to reduce the end peaking of fuel rods.** Sasajima, Hideo (Japan Atomic Energy Research Inst., Tokai, Ibaraki (Japan). Tokai Research Establishment). Japan Atomic Energy Research Inst., Tokyo (Japan). Feb 1990. 17p. (In Japanese). Order Number DE90508047. Available from NTIS (US Sales Only), PC A03/MF A01.

The NSRR experiments are directed to the study of fuel behavior under reactivity-initiated accident conditions. In the previous experiments, only unirradiated fresh fuel rods have been used as the test rods. From 1989, experiments on preirradiated fuel rods have started. The test fuel rods for the preirradiated fuel are prepared by the following two manners: (1) Preirradiation of short sized fuel rods, which design is similar to the present NSRR standard test fuel rods, in JMTR, and (2) Refabrication of spent fuel rods from commercial BWRs and PWRs into short segment rods. In order to prevent the power peaking at the ends of fuel stack, hafnium disk, which has large neutron absorption cross section, are loaded at both ends of fuel pellets stack in the segmented fuel rods during refabrication. Pulse irradiation experiments have been carried out in the NSRR to study the effectiveness of the hafnium disk to reduce the axial power peaking as a function of the disk thickness by using the disks of 0.5mm, 1.0mm, 2.0mm and 4.0mm thick. Obtained results are: (1) Minimum thickness of the hafnium disk to reduce the peaking factor below 1.18 is 2.0mm for a fuel rod with 2.6 w/o enrichment pellets. (2) Within this experimental scope, the peaking factor didn't depend on the thickness of hafnium disk at thickness above 2.0mm. (author).

40746 (JAERI-M–90-032) **Experimental test results of single-channel test rig of T_1 test section, 2: Test results in helium gas conditions heated to 1000degC.** Hino, Ryutaro (Japan Atomic Energy Research Inst., Tokai, Ibaraki (Japan). Tokai Research Establishment); Takase, Kazuyuki; Miyamoto, Yoshiaki; Maruyama, Soh. Japan Atomic Energy Research Inst., Tokyo (Japan). Mar 1990. 50p. (In Japanese). Order Number DE90508066. Available from NTIS (US Sales Only), PC A03/MF A01.

Experimental studies on thermal and hydraulic performance of a fuel channel has been performed with the single-channel test rig of the fuel stack test section (T_1) in order to contribute the licensing of the JAERI's high-temperature gas-cooled reactor (HTTR). Present report showed experimental results obtained by a high temperature test that helium gas was heated up to 1000degc, using a simulated fuel rod of which heat flux distribution was uniform in the axial direction and varied like an exponential and cosine functions, respectively. In this test, friction factors of a fuel channel and heat transfer coefficients of a fuel rod were well correlated, respectively. These data agreed well with previous results. On the other hand, it was showed that there was almost no difference of heat transfer coefficients between three types of the heat flux distributions. (author).

40747 Education and training at the Penn State Breazeale reactor for the past twenty years. Levine, S.H. *Transactions of the American Nuclear Society (USA),* 59: 321-322 (1989). (CONF-890604–: Annual meeting of the American Nuclear Society, Atlanta, GA (USA), 4-8 Jun 1989).

For the past 20 yr, some of the original activities at the Penn State Breazeale Reactor (PSBR) have remained active, whereas other programs have been replaced by new ones. Overall there have been significant changes in research, training, and educational activities, but this was necessary to maintain a strong, viable program at the PSBR. The PSBR has always made an important contribution to the nuclear engineering department's laboratory courses. Activation analysis is a major activity that has continued robustly for the past 20 yr. Activation analysis has spawned a new low-level radiation monitoring laboratory that provides services for the university, local community, and the state. It supports research and broadens the activity in radiation research. The study of monitoring radiation is a focus of the research of a few faculty because of the presence of the PSBR. Recently, two new activities were introduced at the at the PSBR; they are neutron radiography and perturbed angular correlation (PAC). The nuclear engineering faculty that use a research reactor in their curriculum and research will be much stronger than without it. However, a nuclear research reactor facility will only be successful if the nuclear engineering faculty use it as a major tool.

40748 Education and research at the Ohio State University nuclear reactor laboratory. Miller, D.W.; Myser, R.D.; Talnagi, J.W. *Transactions of the American Nuclear Society (USA),* 59: 325-326 (1989). (CONF-890604–: Annual meeting of the American Nuclear Society, Atlanta, GA (USA), 4-8 Jun 1989).

The educational and research activities at the Ohio State University Nuclear Reactor Laboratory (OSUNRL) are discussed in this paper. A brief description of an OSUNRL facility improvement program and its expected impact on research is presented. The overall long-term goal of the OSUNRL is to support the comprehensive education, research, and service mission of OSU.

40749 Education and training at the Rensselaer Polytechnic Institute reactor critical facility. Harris, D.R. *Transactions of the American Nuclear Society (USA),* 59: 326-327 (1989). (CONF-890604–: Annual meeting of the American Nuclear Society, Atlanta, GA (USA), 4-8 Jun 1989).

The Rensselaer Polytechnic Institute (RPI) Reactor Critical Facility (RCF) has provided hands-on education and training for RPI and other students for almost a quarter of a century. The RCF was built in the 1950s by the American Locomotive Company (ALCO) as a critical facility in which to carry out experiments in support of the Army Package power Reactor (APPR) program. A number of APPRs were built and operated. In the middle 1960s, ALCO went out of business and provided the facility to RPI. Since that time, RPI has operated the RCF primarily in a teaching mode in the nuclear engineering department, although limited amounts of reactor research, activation analysis, and reactivity assays have been carried out as well. Recently, a U.S. Department of Energy (DOE) upgrade program supported refueling the RCF with 4.81 wt% enriched UO_2 high-density pellets clad in stainless steel rods. The use of these SPERT (F1) fuel rods in the RCF provided a cost-effective approach to conversion from high-enrichment bombgrade fuel to low-enrichment fuel. More important, however, is the fact that the new fuel is of current interest for light water power reactors with extended lifetime fuel. Thus, not only are critical reactor experiments being carried out on the fuel but, more importantly, the quality of the education and training has been enhanced.

40750 Conversion of the University of Virginia reactor to low-enrichment fuel. Rydin, R.A.; Freeman, D.W.; Fehr, M.K. *Transactions of the American Nuclear Society (USA),* 59: 327-328 (1989). (CONF-890604–: Annual meeting of the American Nuclear Society, Atlanta, GA (USA), 4-8 Jun 1989).

The University of Virginia is using the LEOPARD-LINX-TWODB computational package to assist in converting the 2-MW(thermal) University of Virginia Reactor (UVAR) to low-enrichment uranium fuel (LEU). Recent efforts have been focused on designing an upgraded LEU replacement core. The UVAR is unique in that anywhere from 16 to 27 fuel elements have been used over the years in a variety of geometrical arrangements. However, a compact and fixed core arrangement offers significant operational and experimental advantages over past practice, including a higher and more temporally constant thermal flux. The authors have concentrated on relative burnup comparisons between representative 4 x 4, 4 x 5, and 5 x 5 cores using 18 curved-plant/element HEU (HEU-18) and 18 and 22 flat-plate/element LEU (LEU-18 and LEU-22) fuel. It is concluded that the UVAR should be supplied with LEU-22 fuel. The authors have also explored the reactivity and power-peaking effects of separately varying the reflector compositions on various reactor faces from light water to heavy water to graphite. Thermal-hydraulic behavior has also been analyzed with a combination of the PARET and THERHYD codes, which indicates the LEU cores

will be acceptable with only small modifications in UVAR safety system settings.

40751 Use of the Oregon State University TRIGA reactor for education and training. Dodd, B. *Transactions of the American Nuclear Society (USA),* 59: 331 (1989). (CONF-890604–: Annual meeting of the American Nuclear Society, Atlanta, GA (USA), 4-8 Jun 1989).

This paper summarizes the recent use of the Oregon State University TRIGA Reactor (OSTR) for education and training. In particular, data covering the last 5 yr are presented, which cover education through formal university classes, theses, public information, and school programs. Training is covered by presenting data on domestic and foreign reactor operator training, health physics training, and neutron activation analysis training. While education and training only occupy ~16% of the OSTR's total use time, nevertheless, this is an important mission of all nonpower reactors that cannot be performed effectively in any other way.

40752 Use of the University of Missouri-Rolla reactor in engineering education and training. Straka, M.; Bolon, A.E. *Transactions of the American Nuclear Society (USA),* 59: 332 (1989). (CONF-890604–: Annual meeting of the American Nuclear Society, Atlanta, GA (USA), 4-8 Jun 1989).

The University of Missouri-Rolla Reactor (UMRR) is a thermal reactor licensed for a 200-kW(thermal) steady-state power. Heat generated in the reactor core is transferred to the surrounding pool by natural convection. The maximum thermal neutron flux is 5 × 10^{12} n/cm^2·s. There are three principal irradiation facilities: a pneumatic tube system for a rapid sample transfer, a graphite thermal column, and a beam tube. The facility is operated daily (except on the weekends) by professional staff. Its primary mission includes education, research, service, and training.

40753 The educational role of a large research reactor. Kunze, J.F.; McKibben, J.C. *Transactions of the American Nuclear Society (USA),* 59: 332-334 (1989). (CONF-890604–: Annual meeting of the American Nuclear Society, Atlanta, GA (USA), 4-8 Jun 1989).

Nuclear engineering is a discipline that has special conditions, not common, in general, to most other engineering disciplines, with the exception of aerospace/aeronautical engineering. The conditions demanded by quality assurance, procedural control, certified training, documentation, and reporting expose the nuclear engineering profession to demands that were unheard of two decades ago. These requirements strike with a cruel shock to the dedicated, ambitious, and imaginative new graduate just entering the nuclear industry. Yet, it is essential that the recent graduate accept and work effectively and efficiently within these constraints, which were developed to assure as close to absolute safety for out industry as is possible with reasonable rules and regulations. Compliance with the institutional and regulatory issues is a demanding aspect of the nuclear engineering profession. Today's demands on exactness and reliability in nuclear engineering may be tomorrow's demands on all the other engineering professions. Consequently, at the Columbia campus of the University of Missouri, student training benefits from the fact that our research reactor operates as a round-the-clock production facility, with tight and exacting controls. The one-semester graduate laboratory course is designed to permit the students to learn as much as possible about the true realities of a regulated nuclear engineering and science industry, concentrating on the meaningful analyses and measurements that are a routine part of normal reactor operations.

40754 Use of multiple on-campus reactors in education and training programs. Schlapper, G.A. (Texas A & M Univ., College Station (USA)). *Transactions of the American Nuclear Society (USA),* 59: 334 (1989). (CONF-890604–: Annual meeting of the American Nuclear Society, Atlanta, GA (USA), 4-8 Jun 1989).

In its undergraduate and graduate programs in nuclear engineering and health physics, Texas A&M University utilizes two reactors for the training and education of students. The 5-W AGN-201 nuclear training reactor has been in use since the late 1950s, while the 1-MW TRIGA Nuclear Science Center Reactor (NSCR) was first utilized in late 1961. Both facilities have been upgraded since initial criticality, the AGN power level being increased from the original 200-mW limit to its 5-W current level and the NSCR undergoing conversion from a 100-kW materials test reactor fueled deign to a 1-MW TRIGA-fueled facility. The AGN reactor is operated by the Department of Nuclear Engineering of the College of Engineering and is almost solely utilized in training and education programs. The NSCR facility is administered by the Texas Engineering Experiment Station and support research efforts of faculty and students of departments within and outside the university in addition to contributing to the education and training programs of the nuclear engineering department.

40755 Education program at the Massachusetts Institute of Technology research reactor for pre-college science teachers. Hopkins, G.R.; Fecych, W.; Harling, O.K. *Transactions of the American Nuclear Society (USA),* 59: 334-335 (1989). (CONF-890604–: Annual meeting of the American Nuclear Society, Atlanta, GA (USA), 4-8 Jun 1989).

A Pre-College Science Teacher (PCST) Seminar program has been in place at the Massachusetts Institute of Technology (MIT) Nuclear Reactor Laboratory for 4 yr. The purpose of the PCST program is to educate teachers in nuclear technology and to show teachers, and through them the community, the types of activities performed at research reactors. This paper describes the background, content, and results of the MIT PCST program.

40756 Reactor physics studies of various advanced neutron source reactor core configurations. Primm, R.T. II (Oak Ridge National Lab., TN (USA)). *Transactions of the American Nuclear Society (USA),* 59: 346-347 (1989). (CONF-890604–: Annual meeting of the American Nuclear Society, Atlanta, GA (USA), 4-8 Jun 1989).

The current conceptual design for the core of the advanced neutron source (ANS) reactor is a vertically split, annular geometry composed of involute, thin (1.3-mm) fuel plates and thin (1.3-mm) heavy-water coolant channels. The core would have a heavy-water reflector, and estimates of the total fueled core volume have ranged from 30 to 60 ℓ. Due to control rod and materials irradiation position constraints, the inner radius of the annulus is expected to be at least 110 mm. A goal of the ANS project is to design a facility in which the peak thermal flux in the reflector is 5 to 10 × 10^{19} n/m^2·s. To achieve this goal while maintaining adequate thermal-hydraulic margins, a variety of core configurations have been proposed, two of which are shown. For both the two- and three-element designs, coolant flowing through any single element does not enter the other element(s). The use of three elements allows the length of each element to be smaller - reducing pressure drop and inlet/outlet temperature differential. However, the engineering complexity and cost of the three-element design exceeds that of the two-element design. This paper discusses the relative merits of these designs from a neutronics viewpoint.

40757 Two-point and two-energy group kinetics model of the ANS reactor. Difilippo, F.C. (Oak Ridge National Lab., TN (USA)); Abu-Shehadeh, M.; Perez, R.B. *Transactions of the American Nuclear Society (USA),* 59: 347-348 (1989). (CONF-890604–: Annual meeting of the American Nuclear Society, Atlanta, GA (USA), 4-8 Jun 1989).

The production of extremely high thermal neutron fluxes (~10^{20}/m^2·s) with reasonable power levels (~300 MW) requires the combination of a very undermoderated core and a low-absorbing moderator/reflector (like D_2O). Candidate designs for the reactor of the advanced neutron source (ANS) project have in common the strong coupling between two neutron fields with very different spectra: predominance of epithermal neutrons in the core and thermal neutrons in the reflector. Because there are large variations of the neutron spectra within a few centimetres in a small core, concerns might arise regarding the validity of the conditions under which the point kinetic approach is valid, i.e., the factorization of the flux as the product of two functions: one depending on phase space $\mu(r,v)$ and the other depending only on the time t. In this paper, the authors present a two-point (c and r are the core and reflector, respectively) and two-energy group (1 and 2 are the fast and thermal groups, respectively) model used to calculate power transients in order to detect conditions under which one-point kinetics is not a valid approximation.

40758 A nucleate boiling heat transfer correlation for research reactors using plate-type fuel. Belhadj, M.; Aldemir, T.; Christensen, R.N. *Transactions of the American Nuclear Society (USA),* 59: 360-361 (1989). (CONF-890604–: Annual meeting of the American Nuclear Society, Atlanta, GA (USA), 4-8 Jun 1989).

Although bubble formation is not usually permitted in plate-type research reactor cores under normal operation, the heat flux, which leads to onset of nucleate boiling (ONB) (α_{ONB}) in the hot channel, and the local wall superheat (ΔT_{SAT}) under fully developed nucleate boiling (FDNB) need to be known in analyzing the core response to reactivity or flow excursions. Recent experiments show that q_{ONB} may be largely over- or underestimated if the average channel flow velocity v and channel gap size d are not considered in quantifying q_{ONB} for low-velocity, upward flows in thin, rectangular channels. These flow conditions are relevant to plate-type research reactors following coolant pump trip or when ore cooling under normal operation is by natural convection. The experiments also show that ΔT_{sat} is independent of v in the FDNB regime. This paper investigates the effect of d on ΔT_{sat} in FDNB for upward flows in $2 \leq d \leq 4$-mm rectangular channels, compares the experimental data to predictions by some currently available correlations, and proposes a new correlation to determine ΔT_{sat} within the local pressure p range of 1.36 to 1.48 atm.

40759 Development of a neutron radiography facility at the University of Florida. Vernetson, W.G.; Whaley, P.M. *Transactions of the American Nuclear Society (USA),* 59: 322-324 (1989). (CONF-890604–: Annual meeting of the American Nuclear Society, Atlanta, GA (USA), 4-8 Jun 1989).

The purpose of the work reported in this paper was to provide the University of Florida Training Reactor (UFTR) with more diversified experimental facilities. Specifically, this work was directed to develop a neutron radiography capability at the UFTR for training and education as well as for research and service work if it was deemed possible within a limited budget and staff size constraints.

40760 The role of the Iowa State University research reactor in nuclear engineering education. Williams, R.E.; Hendrickson, R.A. *Transactions of the American Nuclear Society (USA),* 59: 329-331 (1989). (CONF-890604–: Annual meeting of the American Nuclear Society, Atlanta, GA (USA), 4-8 Jun 1989).

On October 19, 1959, the Iowa State University Research Reactor (ISURR) was made critical for the first time. In the 29 yr since then, the reactor has been an integral part of the nuclear engineering program. Throughout its history, the major use of the ISURR has been as an educational tool. The reactor is currently used in both the undergraduate and graduate programs at ISU. The paper provides the reactor description and discusses reactor experiments for undergraduates and reactor use in graduate education.

2207 Plutonium and Isotope Production Reactors

Refer also to citation(s) 40738, 40804, 40805, 40806, 40811, 40812, 41620, 41621, 41622

40761 (HAN–45801) **200 Area monthly production reports, January–June 1947.** Battelle Pacific Northwest Lab., Richland, WA (USA). [1947]. 177p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC06-76RL01830. Order Number DE90014135. Available from NTIS, PC A09/MF A01 - OSTI.

Declassified 19 Jun 1990.

This document contains monthly progress reports for January–June, 1947 for Hanford Engineer Works. Activities at the 200 Area are discussed. (KJD)

40762 (HAN–45830-Del.) **100 Areas monthly report for January 1951: Deletions.** Barnard, M.G. Hanford Works, Richland, WA (USA). 19 Apr 1951. 121p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC06-76RL01830. Order Number DE90014133. Available from NTIS, PC A07/MF A01 - OSTI.

Declassified 19 Jun 1990.

This document contains monthly progress reports for the 100 Area of Hanford Reservation for 1951. Monthly reports discuss pile operation, power outages and shutdowns. (KJD)

40763 (HAN–63605-Del.) **200 Area monthly reports (rough drafts) for 1949.** Battelle Pacific Northwest Lab., Richland, WA (USA). [1949]. 109p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC06-76RL01830. Order Number DE90014134. Available from NTIS, PC A06/MF A01 - OSTI.

Declassified with deletions 15 Jun 1990.

This progress report contains information on the activities at Hanford Reservation for January 1, 1949. Production schedules have been met most satisfactorily in the 200 East and West Areas during January. Improved operational flexibility resulting mainly from the paralleling of the Extraction Cycle plus a minimum number of mechanical and processing difficulties have permitted the initiation of a total of 75 runs. One hundred and seven bottles of product compound have been accepted by the customer. Purities did not drop below 98.8 percent. Material balances averaged 98.0 percent.

40764 (HW–7-6048-Del.) **Hanford Engineer Works monthly report, March 1947: Deletions.** Hanford Works, Richland, WA (USA). 14 Apr 1947. 159p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC06-76RL01830. Order Number DE90014020. Available from NTIS, PC A08/MF A01 - OSTI; GPO Dep.

Declassified 6 June 1990.

This document contains the progress report for March, 1947 for Hanford Engineer Works. The power levels of the Piles at 100 D and 100 F were maintained at 250 MV and 200 MV respectively. The operating time efficiency was 91.6. Forty-nine batches were started in the Canyon Buildings and forty-one were delivered from the Isolation building. There were no major injuries during March and the plant safety record as of March 31 was sixty days. A Supervisors' Training Course has been initiated with sixteen participating members. It is being conducted on a seminar basis and is the trail course to determine the adequacy of the subject material for general use throughout the Hanford Engineer Works. It is expected that an expanded program will be started during the next six weeks to include most of the supervisory personnel now employed at the Works. This is an "on-the-job" training program and part of the general educational planning for the Hanford Engineer Works.

40765 (JAERI-M–90-027) **Release behavior of fission products from irradiated dispersion fuels at high temperatures.** Iwai, Takashi (Japan Atomic Energy Research Inst., Oarai, Ibaraki (Japan). Oarai Research Establishment); Shimizu, Michio; Nakagawa, Tetsuya. Japan Atomic Energy Research Inst., Tokyo (Japan). Feb 1990. 32p. (In Japanese). Order Number DE90508081. Available from NTIS (US Sales Only), PC A03/MF A01.

As a framework of reduced enrichment fuel program of JMTR Project, the measurements of fission products release rates at high temperatures (600degC - 1100degC) were performed in order to take the data to use for safety evaluation of LEU fuel. Three type miniplates of dispersion silicide and aluminide fuel, 20% enrichment LEU fuel with 4.8 gU/cc (U_3Si_2 90 %, USi 10 % and U_3Si_2 50 %, U_3Si 50 % dispersed in aluminium) and 45 % enrichment MEU fuel with 1.6 gU/cc, were irradiated in JMTR. The burnups attained by one cycle (22 days) irradiation were within 21.6 % - 22.5 % of initial ^{235}U. The specimens cut down from miniplates were measured on fission products release rates by means of new apparatus specially designed for this experiment. The specimens were heated up within 600degC - 1100degC in dry air. Then fission products such as ^{85}Kr, ^{133}Xe, ^{131}I, ^{137}Cs, ^{103}Ru, ^{129m}Te were collected at each temperature and measured on release rates. In the results of measurement, the release rates of ^{85}Kr, ^{133}Xe, ^{131}I, ^{129m}Te from all specimens were slightly less than that of G.W. Parker's data on U-Al alloy fuel. For ^{137}Cs and ^{103}Ru from a silicide specimen (U_3Si_2 90 %, USi 10 % dispersed in aluminium) and ^{137}Cs from an aluminide specimen, the release rates were slightly higher than that of G.W. Parker's. (author).

40766 (LA-UR–90-1963) **TRAC [Transient Reactor Analysis Code] analyses of Savannah River 1985 L-Area test series.** Elson, J.S.; Lime, J.F. Los Alamos National Lab., NM (USA). [1990]. 21p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-36. (CONF-900608–44: American Nuclear Society annual meeting, Nashville, TN (USA), 10-14 Jun 1990). Order

Number DE90013179. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Thermal-hydraulic benchmark analyses have been performed using the Transient Reactor Analysis Code (TRAC) for the Savannah River 1985 L-Area AC process flow tests. TRAC models were prepared and run for each of the 11 L-Area steady-state tests. Comparison of the TRAC results with the Savannah River data focused on coolant pressures and flows in the six external loops as well as the magnitude and distribution of coolant pressures in the upper plenum. In general, the TRAC pressures, pressure drops, and coolant flow rates in the external loops are in reasonable agreement with the data. Moreover, although the TRAC results tend to slightly overpredict the upper- plenum pressure data, the results do provide an excellent representation of the radial and azimuthal variations in upper-plenum pressures. Thus, the 1985 L-Area benchmarks lend credibility and confidence to both TRAC and the TRAC Savannah River plant model. 4 refs., 10 figs., 4 tabs.

40767 (OUT–1642) **Shipment histories.** Matthias, F.T. Pacific Northwest Lab., Richland, WA (USA). 23 Apr 1945. 4p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC06-76RL01830. Order Number DE90014202. Available from NTIS, PC A02/MF A01 - OSTI.

Declassified 19 Apr 1990.

Time histories of neutron flux of metal discharged from the Olive pile during shut downs on November 6 and 20, December 20, and January 18, 1945, are presented. 5 tabs. (CBS)

40768 (OUT–1651) **Shipment histories.** Matthias, F.T. Pacific Northwest Lab., Richland, WA (USA). 24 Apr 1945. 2p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC06-76RL01830. Order Number DE90013021. Available from NTIS, PC A02/MF A01 - OSTI.

Declassified 19 Apr 1990.

There is submitted herewith the pile and chemical processing histories of the two sample shipments sent from our consumer. All the product shipments considered resulted from the processing of the metal discharged from the 100-B pile during the shutdowns of 6 November, 20 November, and 20 December 1944. The time histories of the neutron flux for these discharges are given.

40769 (WHC-SA–0465) **Carbon steel and related alloy corrosion in LOMI [low oxidation state metal ion] decontamination solvents.** Larrick, A.P.; Kratzer, W.K.; Richardson, C.A. Westinghouse Hanford Co., Richland, WA (USA). [1988]. 28p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC06-87RL10930. (CONF-8812140–1: 3. EPRI seminar on chemical decontamination of BWR's, Charlotte, NC (USA), 6 Dec 1988). Order Number DE90014342. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

In 1985 UNC Nuclear Industries, now Westinghouse Hanford Company (WHC), began the evaluation of the proprietary LOMI decontamination procedure for its application to the Hanford N Reactor. The LOMI (low oxidation state metal ion) procedure uses the vanadous ion to reduce ferric ion to ferrous ion, thus increasing the ease of dissolution of the iron oxide in the reactor primary cooling system during decontamination. The dissolved oxide is retained in solution by picolinic acid, a weak chelant, until it has been removed from the system. WHC retained London Nuclear Limited, now LN Technologies (LNT), as a consultant to provide information, materials, corrosion testing, and development of the method for applying the LOMI procedure to N Reactor. LNT in turn obtained the assistance of Ontario Research Foundation (ORF) to perform detailed corrosion studies. In addition, the Chemical & Waste Treatment Engineering group, WHC, performed initial laboratory and pilot plant testing of the LOMI decontamination procedure at the anticipated N Reactor application conditions to gain experience in handling and control of the solutions. This document reports the results of the corrosion data obtained during both the ORF and the WHC tests.

40770 Analysis of in-core detector signals from the N reactor at shutdown conditions. Rombough, C.T.; Toffer, H.; Crowe, R.D.; Samuel, T.J. *Transactions of the American Nuclear Society (USA),* 59: 338-340 (1989). (CONF-890604–: Annual meeting of the American Nuclear Society, Atlanta, GA (USA), 4-8 Jun 1989).

Careful analysis has demonstrated that signals from self-powered fixed in-core detectors can be used to measure the spatial distribution of the gamma flux throughout the N reactor, even in the shutdown state. Except for some obvious flux anomalies (caused by radiation sources such as samarium balls), the spatial distribution is related to the fuel burnup surrounding each detector. These measurements have demonstrated that well-designed self-powered fixed in-core detectors can be used to extract meaningful information at flux levels much lower than previously thought. It is significant that a fixed in-core detector system used in conjunction with commercially available signal collection equipment can accurately measure, with a high degree of confidence, neutron and gamma flux distributions in power reactors at power levels on the order of 0.1%.

40771 MCNP photon transport benchmarking calculations performed at Savannah River Plant. White, A.M. *Transactions of the American Nuclear Society (USA),* 59: 345-346 (1989). (CONF-890604–: Annual meeting of the American Nuclear Society, Atlanta, GA (USA), 4-8 Jun 1989).

Monte Carlo methods have long been used at the Savannah River Laboratory (SRL) to perform criticality calculations for many different processes. To perform transport analyses (both neutron and photon), the two-dimensional infinite lattice integral transport code GLASS has been used. The neutron transport portion of the code has been benchmarked against other codes and experimental data. The photon transport portion of the code, which is used to calculate gamma redistribution in the event of a loss of moderator and/or coolant, had not been benchmarked against either. For this reason, the Monte Carlo code MCNP was used to benchmark the photon transport portion of the GLASS code. Preceding this, a brief description of the geometry of the Savannah River Plant's (SRP's) reactor cores and how they were modeled using MCNP is given.

2209 Reactor Safety

Refer also to citation(s) 40397, 40606, 40607, 40619, 40620, 40621, 40651, 40669, 40697, 40700, 40729, 40732, 40737, 40882, 41535

40772 (BMU–1989-222) **Radiation exposure of the population as a result of iron metal scrap from nuclear power plant released for conventional recycling.** Schriftenreihe Reaktorsicherheit und Strahlenschutz. Ergebnisberichte, Untersuchungen, Studien, Gutachten. Goertz, R.; Graf, R.; Knaup, A.G. Bundesministerium fuer Umwelt-, Naturschutz und Reaktorsicherheit, Bonn (Germany, F.R.); Brenk Systemplanung Ingenieurbuero fuer Wissenschaftlich-Technischen Umweltschutz, Aachen (Germany, F.R.). Apr 1988. 181p. (In German). Contract BMU SR 408. Available from GRM Werbeberatung - Werbemittlung - PR, Eggenstein-Leopoldshafen, (Germany, F.R.).

As release criteria, the values indicated in annex IX, column 4 StrlSchV (radiation protection ordinance) for the surface contamination are to be observed, the mass specific activity is limited to 1 Bq/g. In case of scrap from nuclear power stations, it is assumed that there exist only trace amounts of α-emitters. The report deals with the methods for the determination of radiological consequences of the release of scrap steel and scrap iron from nuclear power stations under these limiting conditions as well as the pertaining results. For solving the methodical problems a statistical simulation model for the dose-specific aspects of the recycling has been developed. This starting point seems to be adequate, as the itineraries of a released scrap quantity up to the final product cannot be predicted in detail and are to a large extent governed by chance. The target quantity is the distribution of individual doses to the general population. In this context one may confine to the consideration of the external irradiation by photons. (orig./DG).

40773 (BNL–52243) **RELAP5/MOD2.5 analysis of the HFBR [High Flux Beam Reactor] for a loss of power and coolant accident.** Slovik, G.C.; Rohatgi, U.S.; Jo, Jae. Brookhaven National Lab., Upton, NY (USA). May 1990. 136p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76CH00016. Order Number DE90014716. Available from NTIS, PC A07/MF A01; OSTI; INIS; GPO Dep.

A set of postulated accidents were evaluated for the High Flux Beam Reactor (HFBR) at Brookhaven National Laboratory. A loss of power accident (LOPA) and a loss of coolant accident (LOCA) were analyzed. This work was performed in response to a DOE review that wanted to update the understanding of the thermal hydraulic behavior of the HFBR during these transients. These calculations were used to determine the margins to fuel damage at the 60 MW power level. The LOPA assumes all the backup power systems fail (although this event is highly unlikely). The reactor scrams, the depressurization valve opens, and the pumps coast down. The HFBR has down flow through the core during normal operation. To avoid fuel damage, the core normally goes through an extended period of forced down flow after a scram before natural circulation is allowed. During a LOPA, the core will go into flow reversal once the buoyancy forces are larger than the friction forces produced during the pump coast down. The flow will stagnate, reverse direction, and establish a buoyancy driven (natural circulation) flow around the core. Fuel damage would probably occur if the critical heat flux (CHF) limit is reached during the flow reversal event. The RELAP5/MOD2.5 code, with an option for heavy water, was used to model the HFBR and perform the LOPA calculation. The code was used to predict the time when the buoyancy forces overcome the friction forces and produce upward directed flow in the core. The Monde CHF correlation and experimental data taken for the HFBR during the design verification phase in 1963 were used to determine the fuel damage margin. 20 refs., 40 figs., 11 tabs.

40774 (CONF-900804–31) **EBR-2 [Experimental Breeder Reactor-2] containment seismic analysis.** Gale, J.G.; Lehto, W.K. Argonne National Lab., Idaho Falls, ID (USA). [1990]. 12p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract W-31109-ENG-38. From International topical meeting on fast reactor safety; Snowbird, UT (USA); 12-16 Aug 1990. Order Number DE90013892. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

The Experimental Breeder Reactor-2 (EBR-2) is a liquid metal reactor located at the Argonne National Laboratory near Idaho Falls, Idaho. At the time the EBR-2 was designed and constructed, there were no engineering society or federal guide lines specifically directed toward the seismic design of reactor containment structures; hence, static analysis techniques were used in the design. With the increased focus on safety of reactor and fuel reprocessing facilities, Argonne has initiated a program to analyze its existing facilities for seismic integrity using current Department of Energy guidelines and industry consensus standards. A seismic analysis of the EBR-2 containment building has been performed using finite-element analysis techniques. The containment building is essentially a vertical right cylindrical steel shell with heads on both ends. The structure is unique in that the interior of the steel shell is lined with reinforced concrete. The actual containment function of the building is served by the steel shell; whereas the function of the concrete liner is to serve as a missile shield and a thermal insulating shield to protect the steel containment shell from internally generated missiles and fires. Model development and structural evaluation of the EBR-2 containment building are discussed in this paper. 7 refs., 8 figs.

40775 (CONF-900828–4) **Passive and inherent safety technologies for light-water nuclear reactors.** Forsberg, C.W. Oak Ridge National Lab., TN (USA). Jul 1990. 50p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC05-84OR21400. From Summer national meeting of the American Institute of Chemical Engineers; San Diego, CA (USA); 19-22 Aug 1990. Order Number DE90014215. Available from NTIS, PC A04/MF A01; OSTI; INIS; GPO Dep.

Passive/inherent safety implies a technical revolution in our approach to nuclear power safety. This direction is discussed herein for light-water reactors (LWRs) – the predominant type of power reactor used in the world today. At Oak Ridge National Laboratory (ORNL) the approach to the development of passive/inherent safety for LWRs consists of four steps: identify and quantify safety requirements and goals; identify and quantify the technical functional requirements needed for safety; identify, invent, develop, and quantify technical options that meet both of the above requirements; and integrate safety systems into designs of economic and reliable nuclear power plants. Significant progress has been achieved in the first three steps of this program. The last step involves primarily the reactor vendors. These activities, as well as related activities worldwide, are described here. 27 refs., 7 tabs.

40776 (CONF-900917–3) **Loss-of-coolant accident experiment at the AVR gas-cooled reactor.** Krueger, K. (Arbeitsgemeinschaft Versuchs-Reaktor GmbH, Juelich (Germany, F.R.)); Cleveland, J. Oak Ridge National Lab., TN (USA). [1990]. 18p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC05-84OR21400. From American Nuclear Society topical meeting on safety of non-commercial nuclear reactor research and irradiation facilities; Boise, ID (USA); 30 Sep - 3 oct 1990. Order Number DE90012732. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

A landmark safety test has been conducted at the AVR-reactor, a high-temperature gas-cooled reactor (HTGR) in the Federal Republic of Germany owned by the Arbeitsgemeinschaft Versuchsreaktor, AVR in Juelich. The 46-MW(t), 15-MW(e) AVR reactor was subjected to a simulated loss-of-coolant accident (LOCA), a very severe occurrence in which the coolant escapes from the reactor core and no emergency system provides coolant flow to the core. The test, which demonstrated the inherently safe response of this reactor to a LOCA, marked the first time ever that a reactor has been intentionally subjected to loss-of-coolant conditions without emergency cooling. Oak Ridge National Laboratory (ORNL) and General Atomics participated in the test by working with AVR staff by jointly performing the analyses needed to obtain the license to conduct the test and by performing post test analyses. This participation was carried out under the cooperative AVR Subprogram which is conducted within the US/FRG Agreement for Cooperation in Gas-Cooled Reactor Development. 7 figs.

40777 (CONF-900917–4) **Analysis and modeling of fission product release from heated uranium-aluminum plate-type reactor fuels.** Taleyarkhan, R.P. Oak Ridge National Lab., TN (USA). [1990]. 20p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. From American Nuclear Society topical meeting on safety of non-commercial nuclear reactor research and irradiation facilities; Boise, ID (USA); 30 Sep - 3 oct 1990. Order Number DE90012796. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

This paper provides a perspective overview and analysis of volatile fission product release data obtained for UAl reactor fuels, UAlx (alloy and dispersed), U_3O_8–Al (dispersed), U_3Si_2–Al (dispersed), and U_3Si–Al (dispersed). Several shortcomings in the experimental databases have been highlighted and areas of uncertainty identified related to extrapolation of correlation predictions. It is shown that fission product release characteristics for the UAl reactor fuels are radically different from power reactor fuels. Significant dependencies that exists on ambient medium, rate of release, fuel-type and structure, fission product chemistry, and burnup are analyzed. The potential inaccuracies involved in using the CORSOR (i.e, exponential) approach for modeling release rate dependence for UAl fuels with time are demonstrated and an alternate formulation which captures characteristic trends is suggested. A library of correlations and methods for predicting release rates (for each individual volatile species) which may very with time, ambient environment, burnup, and temperature were developed based upon analysis of characteristic data trends, phenomenological aspect, and regression analysis. A comparison of suggested correlation predictions against measurements resulted in an overall mean value and standard deviation of 1.02 and 0.28, respectively, over the entire temperature range investigated. Overall, statistics improve significantly (mean = 1.0, standard deviation = .10) if the Hanford Engineering and Development Laboratory (HEDL) data (which displayed considerable data scatter) are excluded. 10 refs., 4 figs., 7 tabs.

40778 (CONF-900917–8) **Loss of coolant analysis for the tower shielding reactor 2.** Radcliff, T.D.; Williams, P.T. Oak Ridge National Lab., TN (USA). Jun 1990. 18p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. From American Nuclear Society topical meeting on safety of non-commercial nuclear reactor research and irradiation facilities; Boise, ID (USA); 30 Sep - 3 oct 1990. Order Number DE90013828. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

The operational limits of the Tower Shielding Reactor-2 (TSR-2) have been revised to account for placing the reactor in a beam shield, which reduces convection cooling during a loss-of-coolant accident (LOCA). A detailed heat transfer analysis was performed to set operating time limits which preclude fuel damage during a LOCA. Since a LOCA is survivable, the pressure boundary need not be safety related, minimizing seismic and inspection requirements. Measurements of reactor component emittance for this analysis revealed that aluminum oxidized in water may have emittance much higher than accepted values, allowing higher operating limits than were originally expected. These limits could be increased further with analytical or hardware improvements. 5 refs., 7 figs.

40779 (CONF-9007119–1) **Passive earthquake-resistance through base isolation.** Wu, Ting-Shu; Seidensticker, R.W. Argonne National Lab., IL (USA). Apr 1990. 18p. Sponsored by National Science Foundation. DOE Contract W-31109-ENG-38. From International workshop on intelligent structures; Taiwan (China); 23-26 Jul 1990. Order Number DE90013671. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Base isolation is an effective approach in mitigating the seismic forces transmitted to the superstructure. It is able to provide reliable protection for the superstructure, its contents and occupants. With base isolation, dynamic characteristics of the superstructure and its contents become more predictable and controllable. In recent years, different base isolation systems have been installed in various new and existing buildings, including office buildings, computer centers, buildings for high technology industries, emergency and communication centers, buildings for high technology industries, emergency and communication centers. The concept of seismic isolation is also under active investigation for nuclear power plants, where safety and reliability of these systems are of utmost importance. One such system uses laminated high-damping rubber and steel shim plates vulcanized into a solid bearing. Under a joint program between Shimizu of Japan and Argonne National Laboratory of the United States, such high-damping rubber bearings were installed in the spring of 1989 in a three-story full size test building at the Tohoku University, Sendai, Japan. Within a period of six months after their installation, this test building and the bearings have experienced more than fifteen earthquakes. Valuable information on the performance of the isolation bearings and the building has been (and is continuing to be) gathered and analyzed. Simulation studies of the effects of these earthquakes using lumped mass systems have been conducted, and are in close agreement with the actual observed responses. 3 refs., 11 figs.

40780 (EGG-M–90063) **Risk-based management system development for the Advanced Test Reactor.** Davis, M.L.; Eide, S.A. EG and G Idaho, Inc., Idaho Falls, ID (USA). [1990]. 6p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC07-76ID01570. (CONF-900917–5: American Nuclear Society topical meeting on safety of non-commercial nuclear reactor research and irradiation facilities, Boise, ID (USA), 30 Sep - 3 oct 1990). Order Number DE90013085. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

A Risk-Based Management System (RBMS) is being developed to facilitate the use of the Advanced Test Reactor (ATR) probabilistic risk assessment to support ATR operation. Most ATR RBMS questions can best be answered using the System Analysis and Risk Assessment System (SARA) developed at the Idaho National Engineering Laboratory. However, some applications may require employment of the other four codes used to develop and report the PRA. These four codes include the Integrated Reliability and Risk Analysis System (IRRAS), SETS, ETA-II, and the Nuclear Computerized Library for Assessing Reactor Reliability (NUCLARR). The ATR RBMS will evolve over three years, and will include the results of the Level 3 and external events analysis.

40781 (EGG-M–90229) **TMI-2 analysis exercise: Final report.** EG and G Idaho, Inc., Idaho Falls, ID (USA). 7 May 1990. 29p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC07-76ID01570. (CONF-9005241–1: OECD/TMI-2 joint task group meeting, Tokyo (Japan), 22 May 1990). Order Number DE90013869. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

On March 28, 1979 an accident at the Three Mile Island Unit 2 (TMI-2) nuclear power plant led to melting of approximately 50% of the reactor's core. Since the TMI-2 accident has not been duplicated in an experimental facility, TMI-2 provides a unique opportunity to assess the capability of our severe accident analysis methods to simulate an accident in a full scale nuclear power plant. In this regard the OECD Nuclear Energy Agency (NEA) in collaboration with the US Department of Energy (DOE), has established a Joint Task Group to analyze various periods of the accident in an effort to benchmark severe accident computer codes. Participants in the analysis exercise and contributors to this report are provided and the results and conclusions that may be drawn from these results of the benchmark analyses are documented in this report. 12 refs., 10 figs., 5 tabs.

40782 (EPRI-NP–6818) **Wolf Creek steam line break analysis: Comparison of RETRAN-02 analysis with updated safety analysis report: Final report.** Garrett, T.J. (Wolf Creek Nuclear Operating Corp., Wichita, KS (USA)); Neises, G.J. Electric Power Research Inst., Palo Alto, CA (USA); Wolf Creek Nuclear Operating Corp., Wichita, KS (USA). ©Jul 1990. 52p. Sponsored by Electric Power Research Institute. Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

The Steamline Break transient results are presented to the Electric Power Research Institute (EPRI) to demonstrate the RETRAN analysis of a PWR steamline break. RETRAN analysis results are compared to the Wolf Creek USAR results to demonstrate the adequacy of plant modeling techniques for the Design Basis Accident Methodology with Multidimensional Effects project coordinated by EPRI. 7 refs., 29 figs., 4 tabs.

40783 (EUR–11449) **Radiation protection in the European Community. Evaluation and suggestions.** Bengtsson, G.; Jacobi, W.; Jammet, H.; Pochin, E.; Silini, G.; Wambersie, A. Commission of the European Communities, Luxembourg (Luxembourg). 1988. 283p. Available from NTIS (US Sales Only), PC A13/MF A01.

The accident at Chernobyl has highlighted the need for an independent assessment of the present situation and future actions with respect to the protection of the population in the European Community from the danger of ionizing radiation. The Commission of the European Communities in its Outline communication from the Commission to the Council on the consequences of the Chernobyl accident has announced a series of activities in different fields to take account of the lessons to be learnt from the Chernobyl accident. Problems of safety standards and consequences to health take an important place in these considerations of the Commission. Consequently a Committee of high-level independent scientists has been convoked and asked: (i) to assess the scientific evidence arising from current research in view of recent nuclear incidents and to consider the possible implications for the basic standards and emergency reference levels; and (ii) to advise the Commission on future actions in radiological protection. The Committee met four times between July and November 1986 and discussed all aspects dealing with radiation protection in routine operations and after accidents. The Committee considered the adequacy of present safety standards in the light of available scientific knowledge and paid special attention to radiation protection following nuclear accidents. Rationales for different countermeasures were reviewed and, in particular, the different aspects and methodologies for defining derived emergency reference levels for radioactive contamination in foodstuffs were analysed. Thereby, the Committee did not intend to duplicate the work of the existing Group of Experts set up under Article 31.

40784 (GRS-F–179) **List of reports in the field of reactor safety research of BMFT, CEA, EPRI, JSTA and USNRC. Reported period: October 1 to December 31, 1989.** Gesellschaft fuer Reaktorsicherheit mbH (GRS), Koeln (Germany, F.R.). Feb 1989. 65p. (In German). Order Number DE90510253. Available from NTIS (US Sales Only), PC A04/MF A01.

This list reviews reports from the Federal Republic of Germany, from France, from Japan and from the United States of America concerning single problems in the field of Reactor Safety Research. According to the cooperation of the Bundesminister fuer Forschung und Technologie (BMFT) with the Commissariat a l'Energie Atomique (CEA), the Japan Science and Technology Agency (JSTA),

the Electric Power Research Institute (EPRI) and the United States Nuclear Regulatory Commission, these reports are available in the Gesellschaft fuer Reaktorsicherheit (GRS). The list pursues the following order: Country of origin, problem area concerned, according to the Reactor Safety Research Programm of the BMFT, reporting organization. The list of reports appears quarterly. (orig.).

40785 (INT–215/I) **Tracing of the radioactive cloud in Krakow after the Chernobyl nuclear accident.** Florkowski, T.; Grabczak, J.; Kuc, T.; Rozanski, K. Institute of Physics and Nuclear Techniques, Cracow (Poland). 1987. 29p. Order Number DE90633865. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Results of radioactivity measurements in Cracow after the Chernobyl accident are reported. Methods of sampling air particulates and aerosols, gases (Kr, Xe, CO_2) and results of total beta activity measurements by liquid scintillation counting are presented. Drinking water and dairy milk were also controlled. Several samples were analysed by gamma spectrometry for identification of radionuclides. An attempt to determine alpha emitters did not provide positive results. The influence of Chernobyl accident on the levels of natural tritium in precipitation and atmospheric radiocarbon is also shown. 13 refs., 9 figs., 2 tabs. (author).

40786 (JAERI-M–90-036) **Evaluation report on SCTF Core-III test S3-17: investigation of thermo-hydrodynamic behavior during reflood phase of LOCA in a PWR with vent valves.** Okubo, Tsutomu (Japan Atomic Energy Research Inst., Tokai, Ibaraki (Japan). Tokai Research Establishment); Iguchi, Tadashi; Iwamura, Takamichi; Akimoto, Hajime; Ohnuki, Akira; Abe, Yutaka; Adachi, Hiromichi; Murao, Yoshio; Sakaki, Isao. Japan Atomic Energy Research Inst., Tokyo (Japan). Mar 1990. 129p. Order Number DE90508054. Available from NTIS (US Sales Only), PC A07/MF A01.

In order to investigate the thermo-hydrodynamic behavior during the reflood phase of a loss-of-coolant accident (LOCA) in a pressurized water reactor (PWR) with the vent valves, a reflooding test was performed with the Slab Core Test Facility (SCTF) at Japan Atomic Energy Research Institute (JAERI). The simulated PWR with the vent valves in the test is one manufactured by Brown Boveri Reactor (BBR) in Federal Republic of Germany (FRG). The data obtained in the present test are also supposed to be used for the experimental coupling with the Upper Plenum Test Facility (UPTF) of FRG, based on the trilateral 2D/3D Agreement among FRG, the USA and Japan. The test data have been analyzed by also utilizing other test results. The main conclusions are as follows: (1) It has been demonstrated that the core cooling is significantly good during the reflood phase of a BBR under the best estimate conditions. (2) The intact loop differential pressure was significantly reduced when the vent valve was open. (3) The effect of the vent valve on core cooling was not remarkable under the conditions that the downcomer water level was below the overflow level when the vent valve was closed, but is expected to be remarkable under the conditions that the downcomer water level exceeds to overflow level when the vent valve is closed. (author).

40787 (JAERI-M–90-039) **Data report for ROSA-IV LSTF 10% hot leg break experiment Run SB-HL-02.** Kukita, Yutaka (Japan Atomic Energy Research Inst., Tokai, Ibaraki (Japan). Tokai Research Establishment); Hirata, Kazuo; Gotou, Hiroki. Japan Atomic Energy Research Inst., Tokyo (Japan). Mar 1990. 131p. Order Number DE90508065. Available from NTIS (US Sales Only), PC A07/MF A01.

Experimental data for the 10% hot leg break test, Run SB-HL-02, conducted at the ROSA-IV Large Scale Test Facility (LSTF) on June 30, 1987, are presented. This test assumed total failure of both high pressure injection (HPI) and auxiliary feedwater (AFW) systems. The test results were characterized by asymmetric loop responses, flashing in the cold legs and upper downcomer, as well as condensation depressurization in the cold legs following injection of emergency core coolant (ECC) from accumulators. (author).

40788 (K/CSD/INF–90/28) **Special problems in modeling the high flux isotope reactor with RELAP5.** Wendel, M.W. (Oak Ridge Gaseous Diffusion Plant, TN (USA)); Morris, D.G. Oak Ridge Gaseous Diffusion Plant, TN (USA). [1990]. 16p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC05-84OT21400. (CONF-9009219–1: 1990 joint RELAP5 and TRAC-BWR international user seminar, Chicago, IL (USA), 17-21 Sep 1990). Order Number DE90014316. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

A RELAP5 thermal-hydraulic model of the High Flux Isotope Reactor (HFIR) has been developed to perform calculations for the HFIR Final Safety Analysis Report (FSAR). Modeling problems specific to the HFIR exist because it is a liquid-solid system and experiences low (often subatmospheric) pressures during a loss-of-coolant accident (LOCA). The problem discussed include (1)adequately modeling depressurization of the system, (2) predicting the occurrence of internal choking of the primary coolant flow, and (3) modeling the effects of pump cavitation, which occurs for some LOCAs. An accurate model of the system stiffness has been developed and tested using the RELAP5 control systems capability and seems to be adequate for predicting the behavior of the primary coolant system during a LOCA. The problems with internal choking and pump cavitation have been addressed, but are not yet resolved. 11 refs., 7 figs.

40789 (KFKI–1989-70/G) **The adaption of the RELAP5/mod1 code.** Perneczky, L.; Ezsoel, Gy.; Szabados, L.; Toth, I. Hungarian Academy of Sciences, Budapest (Hungary). Central Research Inst. for Physics. Jan 1990. 39p. (In Hungarian). Order Number DE90634090. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Experiences with the application of RELAP5/mod1 code in evaluation of the LOCA type failure simulation experiments of pressurized water reactors are presented in two parts under the same title. The simulation experiments were performed in the SPES facility (Simulatore PWR per Esperienze di Sicurezza, Italy), in the framework of the project OECD-CSNI International Standard Problem No. 22 (ISP-22). The calculational procedures and the input preparation strategy for WWER-1000 type reactors are described. (R.P.) 11 refs.; 6 figs.; 10 tabs.

40790 (KFKI–1990-08/G) **PMK: a programme for the off-line analysis of PMK-NVH experiments.** Bandurski, Th; Toth, I. Hungarian Academy of Sciences, Budapest (Hungary). Central Research Inst. for Physics. Mar 1990. 38p. Order Number DE90634039. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The single-loop integral test facility PMK-NVH set up at CRIP, Budapest, is a 1:2070 scaled-down model of the Paks Nuclear Power Plant with WWER-440 type reactors. PMK-NVH was designed to investigate thermohydraulic phenomena occurring during hypothetic loss-of-coolant accidents (LOCA). The experiments are to verify rather complex thermohydraulic codes used for safety analysis like RELAP4 and RELAP5. The method of processing measurement results obtained on the PMK-NVH test facility is described. The program presented ensures a successful treatment of all original data files obtained up to 1988. (R.P.) 4 refs.

40791 (LA–11415-MS) **SIMMER-II: A computer program for LMFBR disrupted core analysis.** Bohl, W.R.; Luck, L.B. Los Alamos National Lab., NM (USA). Jun 1990. 926p. Sponsored by Nuclear Regulatory Commission. DOE Contract W-7405-ENG-36. Order Number DE90014435. Available from NTIS, PC A99/MF A01; OSTI; INIS; GPO Dep.

SIMMER-2 (Version 12) is a computer program to predict the coupled neutronic and fluid-dynamics behavior of liquid-metal fast reactors during core-disruptive accident transients. The modeling philosophy is based on the use of general, but approximate, physics to represent interactions of accident phenomena and regimes rather than a detailed representation of specialized situations. Reactor neutronic behavior is predicted by solving space (r,z), energy, and time-dependent neutron conservation equations (discrete ordinates transport or diffusion). The neutronics and the fluid dynamics are coupled via temperature- and background-dependent cross sections and the reactor power distribution. The fluid-dynamics calculation solves multicomponent, multiphase, multifield equations for mass, momentum, and energy conservation in (r,z) or (x,y) geometry. A structure field with nine density and five energy components; a liquid field with eight density and six energy

components; and a vapor field with six density and on energy component are coupled by exchange functions representing a modified-dispersed flow regime with a zero-dimensional intra-cell structure model.

40792 (NUREG–1339) **Resolution of Generic Safety Issue 29: Bolting degradation or failure in nuclear power plants.** Johnson, R.E. Nuclear Regulatory Commission, Washington, DC (USA). Div. of Safety Issue Resolution. Jun 1990. 15p. Sponsored by Nuclear Regulatory Commission. Available from NTIS, PC A03/MF A01 - GPO; OSTI; INIS.

This report describes the US Nuclear Regulatory Commission's (NRC's) Generic Safety Issue 29, "Bolting Degradation or Failure in Nuclear Power Plants," including the bases for establishing the issue and its historical highlights. The report also describes the activities of the Atomic Industrial Forum (AIF) relevant to this issue, including its cooperation with the Materials Properties Council (MPC) to organize a task group to help resolve the issue. The Electric Power Research Institute, supported by the AIF/MPC task group, prepared and issued a two-volume document that provides, in part, the technical basis for resolving Generic Safety Issue 29. This report presents the NRC's review and evaluation of the two-volume document and NRC's conclusion that this document, in conjunction with other information from both industry and NRC, provides the bases for resolving this issue.

40793 (NUREG/CR–5461) **Aging of cables, connections, and electrical penetration assemblies used in nuclear power plants.** Jacobus, M.J. (Sandia National Labs., Albuquerque, NM (USA)). Nuclear Regulatory Commission, Washington, DC (USA). Div. of Engineering; Sandia National Labs., Albuquerque, NM (USA). Jul 1990. 65p. Sponsored by Nuclear Regulatory Commission. DOE Contract AC04-76DP00789. (SAND–89-2369). Available from NTIS, PC A04/MF A01 - GPO; OSTI; INIS.

This report examines effects of aging on cables, connections, and containment electrical penetration assemblies (EPAs). Aging is defined as the cumulative effects that occur to a component with the passage of time. If unchecked, these effects can lead to a loss of function and a potential impairment of plant safety. This study includes a review of component usage in nuclear power plants; a review of some commonly used components and their materials of construction; a review of the stressors that the components might be exposed to in both normal and accident environments; a compilation and evaluation of industry failure data; a discussion of component failure modes and causes; and a brief description of current industry testing and maintenance practices. 51 refs., 12 figs., 12 tabs.

40794 (NUREG/CR–5510) **Evaluations of core melt frequency effects due to component aging and maintenance.** Vesely, W.E. (Science Applications International Corp., Columbus, OH (USA)); Kurth, R.E.; Scalzo, S.M. Nuclear Regulatory Commission, Washington, DC (USA). Div. of Engineering; Science Applications International Corp., Columbus, OH (USA). Jun 1990. 232p. Sponsored by Nuclear Regulatory Commission. (SAIC–89/1744). Available from NTIS, PC A11/MF A01 - GPO; OSTI; INIS.

A methodology is developed to incorporate aging effects into a Probabilistic Risk Analysis (PRA). The methodology separates the PRA models from the aging models, allowing available PRAs to be efficiently used in evaluating risk effects of aging. The methodology is applied to two PRAs to demonstrate the results which are obtainable from current PRAs. Various component aging rates and various surveillance and maintenance programs are evaluated to determine their impacts on the resulting core melt frequency. Both point evaluations and uncertainty evaluations are carried out. The results of the applications show that for given aging rates, the core melt frequency impacts are very sensitive to the surveillance and maintenance program which is carried out. The detailed results which are obtained allow the aging contributors to be effectively prioritized to focus aging management programs.

40795 (NUREG/CR–5519-Vol.1) **Aging of control and service air compressors and dryers used in nuclear power plants: Volume 1.** Moyers, J.C. (Oak Ridge National Lab., TN (USA)). Nuclear Regulatory Commission, Washington, DC (USA). Div. of Engineering; Oak Ridge National Lab., TN (USA). Jul 1990. 124p. Sponsored by Nuclear Regulatory Commission. DOE Contract AC05-84OR21400. (ORNL–6607-Vol.1). Available from NTIS, PC A07/MF A01 - GPO; OSTI; INIS.

This report was produced under the Detection of Defects and Degradation Monitoring of Nuclear Plant Safety Equipment element of the Nuclear Plant Aging Research Program. This element includes the identification of practical and cost-effective methods for detecting, monitoring, and assessing the severity of time-dependent degradation (aging) of control and service air compressors and dryers in nuclear power plants. These methods are to provide capabilities for establishing degradation trends prior to failure and developing guidance for effective maintenance. The topics of this Phase 1 assessment report are failure modes and causes resulting from aging, manufacturer–recommended maintenance and surveillance practices, and measurable parameters (including functional indicators) for use in assessing operational readiness, establishing degradation trends, and detecting incipient failure. the results presented are based on information derived from operating experience records, manufacturer-supplied information, and input from plant operators. For each failure mode, failure causes are listed by subcomponent, and parameters potentially useful for detecting degradation that could lead to failure are identified. 13 refs., 9 figs., 16 tabs.

40796 (NUREG/CR–5568-Vol.1) **Industry based performance indicators for nuclear power plants: Phase 1 report, June 1989–February 1990: Volume 1.** Connelly, E.M. (Communications Technology Applications, Inc., McLean, VA (USA)); Van Hemel, S.B.; Haas, P.M. Nuclear Regulatory Commission, Washington, DC (USA). Div. of Systems Research; Communications Technology Applications, Inc., McLean, VA (USA); Concord Associates, Inc., Knoxville, TN (USA). Jul 1990. 96p. Sponsored by Nuclear Regulatory Commission. Available from NTIS, PC A05/MF A01 - GPO; OSTI; INIS.

This report presents the results of the first phase of a two-phase study, performed with the goal of developing indirect (leading) indicators of nuclear power plant safety, using other industries as a model. It was hypothesized that other industries with similar public safety concerns could serve as analogs to the nuclear power industry. Many process industries have many more years of operating experience, and many more plants than the nuclear power industry, and thus should have accumulated much useful safety data. In Phase 1, the investigators screened a variety of potential industry analogs and chose the chemical/petrochemical manufacturing industry as the primary analog for further study. Information was gathered on safety programs and indicators in the chemical industry, as well as in the nuclear power industry. Frameworks were selected for the development of indicators which could be transferred from the chemical to the nuclear power environment, and candidate sets of direct and indirect safety indicators were developed. Estimates were made of the availability and quality of data in the chemical industry, and plans were developed for further investigating and testing these candidate indicators against safety data in both the chemical and nuclear power industries in Phase 2. 38 refs., 4 figs., 7 tabs.

40797 (NUREG/CR–5588-Vol.1) **CARES (Computer Analysis for Rapid Evaluation of Structures) Version 1.0, seismic module: Theoretical manual: Volume 1.** Xu, J. (Brookhaven National Lab., Upton, NY (USA)); Philippacopoulas, A.J.; Miller, C.A.; Costantino, C.J. Nuclear Regulatory Commission, Washington, DC (USA). Div. of Engineering; Brookhaven National Lab., Upton, NY (USA). Jul 1990. 79p. Sponsored by Nuclear Regulatory Commission. DOE Contract AC02-76CH00016. (BNL-NUREG–52241-Vol.1). Available from NTIS, PC A05/MF A01 - GPO; OSTI; INIS.

During FY's 1988 and 1989, Brookhaven National Laboratory (BNL) developed the CARES system (Computer Analysis for Rapid Evaluation of Structures) for the US Nuclear Regulatory Commission (NRC). CARES is a PC software system which has been designed to perform structural response computations similar to those encountered in licencing reviews of nuclear power plant structures. The docomentation of the Seismic Module of CARES consists of three volumes. This report represents Volume 1 of the three volume documentation of the Seismic Module of CARES. It

concentrates on the theoretical basis of the system and presents modeling assumptions and limitations as well as solution schemes and algorithms of CARES. 31 refs., 6 figs.

40798 (NUREG/CR–5588-Vol.2) **CARES (Computer Analysis for Rapid Evaluation of Structures) Version 1.0, seismic module: User's manual: Volume 2.** Xu, J. (Brookhaven National Lab., Upton, NY (USA)); Philippacopoulas, A.J.; Miller, C.A.; Costantino, C.J. Nuclear Regulatory Commission, Washington, DC (USA). Div. of Engineering; Brookhaven National Lab., Upton, NY (USA). Jul 1990. 108p. Sponsored by Nuclear Regulatory Commission. DOE Contract AC02-76CH00016. (BNL-NUREG–52241-Vol.2). Available from NTIS, PC A06/MF A01 - GPO; OSTI; INIS.

During FY's 1988 and 1989, Brookhaven National Laboratory (BNL) developed the CARES system (Computer Analysis for Rapid Evaluation of Structures) for the US Nuclear Regulatory Commission (NRC). CARES is a PC software system which has been designed to perform structural response computations similar to those encountered in licensing reviews of nuclear power plant structures. The documentation of the Seismic Module of CARES consists of three volumes. This report is Volume 2 of the three volume documentation of the Seismic Module of CARES and represents the User's Manual. 14 refs.

40799 (NUREG/CR–5588-Vol.3) **CARES (Computer Analysis for Rapid Evaluation of Structures) Version 1.0, seismic module: Sample problems: Volume 3.** Xu, J.; Philippacopoulas, A.J.; Miller, C.A.; Costantino, C.J. Nuclear Regulatory Commission, Washington, DC (USA). Div. of Engineering; Brookhaven National Lab., Upton, NY (USA). Jul 1990. 144p. Sponsored by Nuclear Regulatory Commission. DOE Contract AC02-76CH00016. (BNL-NUREG–52241-Vol.3). Available from NTIS, PC A07/MF A01 - GPO; OSTI; INIS.

During FY's 1988 and 1989, Brookhaven National Laboratory (BNL) developed the CARES system (Computer Analysis for Rapid Evaluation of Structures) for the US Nuclear Regulatory Commission (NRC). CARES is a PC software system which has been designed to perform structural response computations similar to those encountered in licensing reviews of nuclear power plant structures. The documentation of the Seismic Module of CARES consists of three volumes. This report represents Volume 3 of the volume documentation of the Seismic Module of CARES. It presents three sample problems typically encountered in the Soil-Structure Interaction analyses. 14 refs., 36 figs., 2 tabs.

40800 (NUREG/CR–5589) **Assessment of ice-condenser containment performance issues.** Nourbakhsh, H.P. (Brookhaven National Lab., Upton, NY (USA)). Nuclear Regulatory Commission, Washington, DC (USA). Div. of Safety Issue Resolution; Brookhaven National Lab., Upton, NY (USA). Jul 1990. 41p. Sponsored by Nuclear Regulatory Commission. DOE Contract AC02-76CH00016. (BNL-NUREG–52242). Available from NTIS, PC A04/MF A01 - GPO; OSTI; INIS.

Vulnerabilities of an ice-condenser containment to challenges that could arise from severe accidents have been assessed. The phenomenological issues associated with containment challenges have been evaluated. A number of containment improvements which have the potential to mitigate severe accident challenges have been evaluated. This report is intended to provide a comprehensive statement of the relevant issues that can be used in the NRC staff's evaluation process and by the utilities during their individual plant examinations (IPEs). 44 refs., 8 figs., 10 tabs.

40801 (ORNL/FTR–3659) **[Management of severe accidents at PWR [pressurized water reactor] nuclear power plants]: Foreign trip report, June 25–June 29, 1990.** Malinauskas, A.P. Oak Ridge National Lab., TN (USA). 9 Jul 1990. 5p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC05-84OR21400. Order Number DE90013394. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The traveler vacationed in Ljubljana, Yugoslavia. While there, he delivered three lectures at the Nuclear Training Center of the "Jozef stefan" Institute as a consultant to the IAEA.

40802 (ORNL/FTR–3671) **[UA1 reactor fuels safety and performance]: Foreign trip report, June 25–28, 1990.** Taleyarkhan, R.P. Oak Ridge National Lab., TN (USA). 13 Jul 1990. 15p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE90014302. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The traveler visited several reactor and hot cell experimental facilities connected with JAERI at the Oarai and Tokai establishments. Uranium silicide fission product release experimental data and related acquisition systems were discussed. A presentation was made by the traveler on analysis and modeling of fission product release from UAl reactor fuels. Data obtained by JAERI thus far were offered to the traveler for Oak Ridge National Laboratory (ORNL) review and analysis. This data confirmed key aspects of ORNL theoretical model predictions and will be useful for Advanced Neutron Source (ANS) design. The Oarai establishment expressed their interest and willingness to pursue ORNL/JAERI cooperative efforts in understanding volatile fission product release behavior from silicide fuels. The traveler also presented a perspective overview on ORNL severe accident analysis technology and identified areas for cooperation in JAERI's forthcoming transient testing program. JAERI staff presented plans for evaluating silicide fuel performance under transient reactivity insertion accident conditions in the Nuclear Safety Research Reactor (NSRR) facility. A surprise announcement was made concerning JAERI's most recent initiative relating to the construction of a safety demonstration reactor (SDR) at the Tokai site. The purpose of this reactor facility would be to demonstrate operational safety of both Pressurized Water Reactors (PWRs) and Boiling Water Reactors (BWRs) in support of Japan's nuclear power industry.

40803 (REG/G–3.66) **Standard format and content of financial assurance mechanisms required for decommissioning under 10 CFR parts 30, 40, 70, and 72.** Nuclear Regulatory Commission, Washington, DC (USA). Office of Nuclear Regulatory Research. Jun 1990. 116p. Sponsored by Nuclear Regulatory Commission. Available from NTIS, PC A06/MF A01 - GPO; OSTI; INIS.

The purpose of this regulatory guide, "Standard Format and Content of Financial Assurance Mechanisms Required for Decommissioning Under 10 CFR Parts 30, 40, 70, and 72," is to provide guidance acceptable to the NRC staff on the information to be provided for establishing financial assurance for decommissioning and to establish a standard format for presenting the information. Use of the standard format will help ensure that the financial instruments contain the information required by 10 CFR Parts 30, 40, 70, and 72; aid the applicant and NRC staff in ensuring that the information is complete; and help persons reading the financial instruments to locate information. This guide address financial assurance for decommissioning of facilities under materials licenses granted under Parts 30, 40, 70, and 72. These parts include licensees in the following categories: Part 30, Byproduct Material; Part 40, Source Material; Part 70, Special Nuclear Material; and Part 72, Independent Spent Fuel Storage Installations.

40804 (SAND–89-2101-Vol.1) **N Reactor Probabilistic Risk Assessment supporting calculations: Volume 1, Main report.** Miller, L.A. (Sandia National Labs., Albuquerque, NM (USA)); Wyss, G.D.; Kunsman, D.M.; Dingman, S.E.; Boucheron, E.A.; Carmel, M.K.; Shaffer, C.J. Sandia National Labs., Albuquerque, NM (USA). Jun 1990. 309p. Sponsored by U.S. DOE Environment Health & Safety. DOE Contract AC04-76DP00789. Order Number DE90014707. Available from NTIS, PC A14/MF A01; OSTI; INIS; GPO Dep.

Prepared for Westinghouse Hanford Company, Richland, WA.

A Level 3 Probabilistic Risk Assessment (PRA) has been performed for N Reactor, a Department of Energy production reactor. The phenomenological calculations made in support of the PRA with HECTR and MELCOR are presented in this report. These calculations are an integral part of the Level 2 PRA since they provide quantitative input to the Accident Progression Event Tree and Parametric Source Term Model. Without these calculations, gaps in the understanding of the phenomena that may occur at N Reactor would increase the uncertainty of the risk. These calculations include two transient accident sequences and several sensitivity studies dealing with issues ranging from hydrogen production to the mitigative effect of the banana wall.

40805 (SAND–89-2101-Vol.2) **N Reactor Probabilistic Risk Assessment supporting calculations: Volume 2, Appendices A–G.** Miller, L.A. (Sandia National Labs., Albuquerque, NM (USA)); Wyss, G.D.; Kunsman, D.M.; Dingman, S.E.; Boucheron, E.A.; Carmel, M.K.; Shaffer, C.J. Sandia National Labs., Albuquerque, NM (USA). Jun 1990. 735p. Sponsored by U.S. DOE Environment Health & Safety. DOE Contract AC04-76DP00789. Order Number DE90014703. Available from NTIS, PC A99/MF A01; OSTI; INIS; GPO Dep.

Prepared for Westinghouse Hanford Company, Richland, WA.

A Level 3 Probabilistic Risk Assessment (PRA) has been performed for N Reactor, a Department of Energy production reactor. The phenomenological calculations made in support of the PRA with HECTR and MELCOR are presented in this report. These calculations are an integral part of the Level 2 PRA since they provide quantitative input to the Accident Progression Event Tree and Parametric Source Term Model. Without these calculations, gaps in the understanding of the phenomena that may occur at N Reactor would increase the uncertainty of the risk. These calculations include two transient accident sequences and several sensitivity studies dealing with issues ranging from hydrogen production to the mitigative effect of the banana wall. This volume contains appendices A–G.

40806 (SAND–90-0115C) **MELCOR adaptation and validation for modeling of N Reactor core phenomena.** Wyss, G.D.; Summers, R.M.; Miller, L.A. Sandia National Labs., Albuquerque, NM (USA). [1990]. 18p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. (CONF-900917–1: American Nuclear Society topical meeting on safety of non-commercial nuclear reactor research and irradiation facilities, Boise, ID (USA), 30 Sep - 3 oct 1990). Order Number DE90012225. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

MELCOR has been adapted for use in modeling the N Reactor core as a part of the recently completed N Reactor probabilistic risk assessment. Significant adaptation of MELCOR was required because of the horizontal, water cooled, graphite-moderated nature of the N Reactor core. The generation and verification of the revised N Reactor core model are described in this paper. A hydrogen production and core damage benchmark calculation is presented in which all significant parameters calculated by MELCOR agreed with those in the reference calculation to within approximately 10%. The reference calculation required many CRAY CPU hours, while the MELCOR calculation was completed in less than 20 CPU minutes on a VAX 8700. 7 refs., 3 figs., 1 tab.

40807 (SIEMENS-KWU-U9–414/87/030) **Construction and startup of the UPTF. Final report.** Sawitzki, M.; Kuehlwein, K.; Winkler, F.; Emmerling, R.; Hertlein, R.; Gaul, H.P. Siemens AG Unternehmensbereich KWU, Erlangen (Germany, F.R.). Geschaeftsgebiet Nukleare Energieerzeugung; Bundesministerium fuer Forschung und Technologie, Bonn (Germany, F.R.). Mar 1988. 211p. (In German). Contract BMFT 1500 500/8. Available from Copy held by UB/TIB Hannover.

Within the terms of the reactor emergency core cooling program, the Upper Plenum Test Facility (UPTF) has been constructed and commissioned with the Federal Minister for Research and Technology as sponsor and the Gesellschaft fuer Reaktorsicherheit as project contractor. The test facility serves to investigate the thermohydraulic processes taking place in the upper plenum, in the downcomer and in the reactor coolant piping of a pressurized water reactor in the wake of a postulated loss-of-coolant accident. The test facility models the primary loop system of the Grafenrheinfeld pressurized water reactor on a scale of 1:1. The reactor core, the steam generators and the reactor coolant pumps were replaced by simulators. The experiments performed after commissioning are linked with the analysis of new three-dimensional computer codes. Of the accident conditions to be investigated, the end of the depressurization phase, the refill and the reflood phase are investigated in the facility. (orig.) With 21 refs., 14 tabs., 103 figs.

40808 (SIEMENS-KWU-U9–414/89/001) **Experimental analysis of the behaviour of Iodine in the event of hypothetical accidents. Pt. 1. Droplet carry-over. Final report (revised version).** Richter, F.; Rippel, R.; Proebstle, G.; Fernholz, O. Siemens AG Unternehmensbereich KWU, Erlangen (Germany, F.R.). Werkstoffe und Chemie; Technische Hochschule Aachen (Germany, F.R.). Lehrstuhl und Inst. fuer Dampf- und Gasturbinen; Bundesministerium fuer Forschung und Technologie, Bonn (Germany, F.R.). Jan 1989. 96p. (In German). Contract BMFT 1500 709/2. Available from Copy held by UB/TIB Hannover.

Replaces edition of June 1986 (R 917/86/009) = INIS-mf–10617.

Experiments have been performed simulating hypothetical core-melt accidents in order to determine droplet-bound transport of radio-nuclides. Different measurement methods have been applied to evaluate - steam moisture and droplet size distribution (light-scattering measurements) - the carry-over factor of a tracer substance, and, - to some extent, droplet velocity (laser-Doppler-velocimetry) under atmospheric sump water boiling conditions. The droplet carry-over factor measured between 40 cm and 120 cm above the sump is of the order of 10^{-5}. Here the tracer technique and light-scattering technique give approximately the same results. The light-scattering measurements give a volumetrically averaged droplet diameter of about 5 microns at the heights mentioned above. The laser-Doppler-velocimetry indicates that the carry-over results represent a source term. The effective droplet release from a containment leakage may be lower when consideration is taken of the fact that a droplet fraction falls back into the sump or deposits on walls in the containment. (orig.) With 6 refs., 18 tabs., 34 figs.

40809 (TPR-NS–31-No.2) **Nuclear Safety: Technical progress review, April–June 1990: Volume 31, No. 2.** Silver, E.G. (ed.). Oak Ridge National Lab., TN (USA). [1990]. 140p. Sponsored by U.S. DOE Environment Health & Safety. Available from GPO; $8.50.

This document is a review journal that covers significant developments in the field of nuclear safety. Its scope includes the analysis and control of hazards associated with nuclear energy, operations involving fissionable materials, and the products of nuclear fission and their effects on the environment. Primary emphasis is on safety in reactor design, construction, and operation; however, the safety aspects of the entire fuel cycle, including fuel fabrication, spent-fuel processing, nuclear waste disposal, handling of radioisotopes, and environmental effects of these operations, are also treated.

40810 (WHC-EP–0240-2) **NUSAR: N Reactor Updated Safety Analysis Report, Amendment 21.** Smith, G.L. Westinghouse Hanford Co., Richland, WA (USA). Dec 1989. 1488p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC06-87RL10930. Order Number DE90014395. Available from NTIS, PC A99/MF A01 - OSTI; GPO Dep.

The enclosed pages are Amendment 21 of the N Reactor Updated Safety Analysis Report (NUSAR). NUSAR, formerly UNI-M-90, was revised by 18 amendments that were issued by UNC Nuclear Industries, the contractor previously responsible for N Reactor operations. As of June 1987, Westinghouse Hanford Company (WHC) acquired the operations and engineering contract for N Reactor and other facilities at Hanford. The document number for NUSAR then became WHC-SP-0297. The first revision was issued by WHC as Amendment 19, prepared originally by UNC. Summaries of each of the amendments are included in NUSAR Section 1.1.

40811 (WHC-SA–0822) **DOE safety goals comparison using NUREG-1150 PRA [probabilistic risk assessment] methodology.** Wang., O.S.; Zentner, M.D.; Rainey, T.E. Westinghouse Hanford Co., Richland, WA (USA). Jun 1990. 10p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC06-87RL10930. (CONF-900917–9: American Nuclear Society topical meeting on safety of non-commercial nuclear reactor research and irradiation facilities, Boise, ID (USA), 30 Sep - 3 oct 1990). Order Number DE90014401. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

A full-scope Level 3 probabilistic risk assessment (PRA) including external events has been performed for N Reactor, a US Department of Energy (DOE) Category A production reactor. This four-year, multi-million dollar task was a joint effort by Westinghouse Hanford Company, Science Applications International Corporation (SAIC), and Sandia National Laboratories (SNL). Technical lead in external events and NUREG-1150 methodology was provided by SNL. SAIC led the effort in the Level 1 analysis for the

internally initiated events. Westinghouse Hanford supported the task in many key areas, such as data collection and interpretation, accident progression, system interaction, human factor analyses, expert elicitation, peers review, etc. The main objective of this Level 3 PRA are to assess the risks to the public and onsite workers posed by the operation of N Reactor, to identify modifications to the plant that could reduce the overall risk, and to compare those risks to the proposed DOE and Nuclear Regulatory Commission (NRC) quantitative safety goals. This paper presents the methodology adopted by Westinghouse Hanford and SNL for estimating individual health risks, and the comparison of the N Reactor results and DOE quantitative nuclear safety guidelines. This paper is devoted to DOE quantitative safety guidelines interpretation and comparison; the NRC safety objectives are also presented in order to compare N Reactor results to commercial nuclear power plants included in the NUREG-1150 study. 7 refs., 7 tabs.

40812 (WHC-SA–0966) **Analysis of potential active component aging effects indicators at the N Reactor.** Zentner, M.D.; Wilson, G.P. Westinghouse Hanford Co., Richland, WA (USA). Jun 1990. 7p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC06-87RL10930. (CONF-900980–1: 3. ENS/ANS/FORATOM joint European Nuclear Congress and technology/industry exposition: looking into nuclear's future in the 21st century, Lyon (France), 23-28 Sep 1990). Order Number DE90013867. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

An attempt was made to develop techniques for detecting aging effects or increases in catastrophic failures of safety related equipment at the N Reactor, using an equipment failure rate database developed as part of the N Reactor Level 1 Probabilistic Risk Assessment (PRA). 2 refs., 8 figs., 2 tabs.

40813 Research needs for fatigue damage assessment in PWR surge and spray piping. Shah, V.N. (Idaho National Engineering Lab., Idaho Falls, ID (USA)); Conley, D.A. pp. 87-92 of Transactions of the 10th international conference on structural mechanics in reactor technology: Volume F. Hadjian, A.H. American Association for Structural Mechanics in Reactor Technology, Los Angeles, CA (USA) (1989). DOE Contract AC07-76ID01570. (CONF-890855–: 10. international conference on Structural Mechanics in Reactor Technology (SMIRT), Anaheim, CA (USA), 14-18 Aug 1989).

This paper identifies the research necessary for revising regulator requirements so that fatigue damage in PWR surge and spray piping can be realistically assessed, for developing and modifying ASME codes and standards so that fatigue damage can be detected and monitored, and for revising design practices and operating procedures so that the fatigue damage can be reduced. The authors discuss operating conditions leading to stratified flows and thermal striping, high- and low-cycle fatigue damage, estimation and detection of fatigue damage and conclusions and recommendations.

40814 Human reliability impact on in-service inspection. Spanner, J.C. Sr. (Pacific Northwest Lab., Richland, WA (USA)). pp. 89-96 of Proceedings of the 8th international conference on NDE in the nuclear industry. Stahl, D. American Society for Metals, Metals Park, OH (USA) (1986). DOE Contract AC06-76RL01830. (CONF-8611147–: 8. international conference on NDE in the nuclear industry, Kissimmee, FL (USA), 17-19 Nov 1986).

This paper describes a study conducted to identify, characterize, and evaluate the human reliability aspects of ultrasonic testing/ inservice inspection (UT/ISI). Recent measurements of UT/ISI system effectiveness have revealed wide variations in performance; suggesting that insufficient emphasis is being placed on the human reliability aspects of nondestructive examination. It appears that NDE performance can be improved through application of the human factors principles relating to the task, training, procedure, environmental, and individual difference variables. These variables are collectively referred to as performance-shaping factors. A man-machine systems model was developed to describe the UT/ISI process using functional task descriptors. The relative operating characteristic (ROC) analysis method, which is derived from signal detection theory, offers unique attributes for analyzing NDT performance. The results of a limited human factors evaluation conducted in conjunction with a mini-round robin test are also described.

40815 An evaluation of current capabilities in characterization of intergranular stress corrosion cracking. Taylor, T.T. (Pacific Northwest Lab., Richland, WA (USA)); Heasler, P.G.; Bates, D.J. pp. 75-82 of Proceedings of the 8th international conference on NDE in the nuclear industry. Stahl, D. American Society for Metals, Metals Park, OH (USA) (1986). DOE Contract AC06-76RL01830. (CONF-8611147–: 8. international conference on NDE in the nuclear industry, Kissimmee, FL (USA), 17-19 Nov 1986).

This paper reports on a piping inspection round robin. The mini round robin (MRR) measured the capability of in-service inspection technicians that had recently completed training required by IEB 83-02 to detect and characterize IGSC cracks. The MRR data base was compared with an earlier pipe inspection round robin (PIRR). The comparison of the MRR and PIRR data bases indicates no change in inspection detection capability.

40816 Nuclear Regulatory Commission initiative for technical specification improvement. Reinhart, M. *Transactions of the American Nuclear Society (USA),* 59: 294 (1989). (CONF-890604–: Annual meeting of the American Nuclear Society, Atlanta, GA (USA), 4-8 Jun 1989).

From early 1982 through 1984, the NRC, with industry's attention, engaged in several initiatives and studies to improve technical specifications. These activities resulted in the February 1987 interim Commission Policy Statement on Technical Specifications Improvements. The policy statement focused on the purpose of technical specifications to identify features that are of controlling importance to safety and to establish on them conditions to assure safe operation that cannot be changed without prior commission approval. The NRC reviewed industry's-represented by the Nuclear Management Resources Council, the four nuclear steam supply system owners' groups, and several of their member utilities-application of the interim policy statement's criteria to standard technical specifications (STSs). As a result, a split was established in May 1988: ~40% of the current limiting condition for operations (LCO) and surveillance requirements were identified as candidates for relocation to other documents such as the final safety analysis report (FSAR), programs, or procedures. The new STSs are to be living documents. As the NRC and industry continue to gain experience, additional improvements are to be made to the STSs. The guidance of the final policy statement is to be used to screen future generic items for inclusion in technical specifications.

40817 New usable technical specifications. Webster, S.A.; Tomasi, L.T.; Bernier, R.A. *Transactions of the American Nuclear Society (USA),* 59: 295-296 (1989). (CONF-890604–: Annual meeting of the American Nuclear Society, Atlanta, GA (USA), 4-8 Jun 1989).

After 2 yr of preparation, 1988 finally saw the nuclear industry writing operator-oriented technical specifications. This effort is a continuation of previous efforts to develop improved and usable standard technical specifications (STSs), and is being conducted by the four nuclear steam supply system vendor owners' groups under the auspices of the Nuclear Management Resources Council. Each participant is currently preparing a set of improved STSs based on a writer's guide that was developed through a combined industry effort. In May of 1987, a Human Factors Improvements to Technical Specifications (HFITS) task group was formed to prepare a writer's guide for improved, industrywide STSs. This task group was composed of two representatives from each owners' group, one with a human factors background and one with some operations background. Two documents were prepared in 6 months, a human factors report laying the groundwork for the considerations to go into technical specifications and a writer's guide for their preparation. This paper reports on the application of this writer's guide to the writing of improved STS.

40818 On the retrievability and control of design basis information. Zaalouk, M.G.; Morris, M.L. *Transactions of the American Nuclear Society (USA),* 59: 299-300 (1989). (CONF-890604–: Annual meeting of the American Nuclear Society, Atlanta, GA (USA), 4-8 Jun 1989).

For several years, the nuclear industry has been attempting to sustain an effective configuration management program for the nation's operating nuclear power plants. Design basis information

retrievability and control have become the stumbling blocks for nuclear utilities to survive recent Nuclear Regulatory Commission safety system functional and outage modifications inspections. As a result, utilities have been forced to initiate costly programs for retrieving their plants' design basis information in order to generate verified and controlled plant system design basis documents. Several of these programs are being initiated without a proper linkage to an overall plant configuration program. An approach was adopted that incorporates an integrated configuration management model that clearly separates design basis information from design information. Figure 1 shows the basic elements of the model. The model links design basis information with the other major configuration management information elements and illustrates the importance of such a linkage from both the control of changes and the value added viewpoints. The value added stems from the fact that a single retrievability effort combined with a once-through information screening and data base build up can support the configuration management program as well as design basis reconstitution program with no significant increase in cost.

40819 Design basis reconstitution and configuration management of nuclear power plants. Smith, P.R. *Transactions of the American Nuclear Society (USA),* 59: 298-299 (1989). (CONF-890604–: Annual meeting of the American Nuclear Society, Atlanta, GA (USA), 4-8 Jun 1989).

The major design requirements of nuclear power plant components, systems, and structures are found in the plant's licensing commitments documented in the Final Safety Analysis Report and in the technical specification commitments of the plant. These specifications consider the original design and its degradation by in-service use. Before a nuclear power plant begins operation, the plant systems, structures, and organizational elements are functionally arranged to operate in a particular way. This functional arrangement is specified by the plant's design requirements and is called its configuration. The paper discusses configuration management and information management for configuration management. The management of large amounts of information and the various information systems associated with nuclear generating facilities is an ever-growing challenge for utilities. Plant operations involve a complex interrelation among data elements, especially in relation to design modifications and operational changes. Consequently, the operation of these data systems is interrelated and, as a result, redundant data items may exist. Thus, in view of the need to control and manage the plant configuration baseline, managers are striving to streamline their information management programs, which usually involves the integration of data-base systems.

40820 Acoustic flow measurement optimizes power output at Rochester Gas and Electric, Ginna plant. Pham, C.H.; Cernik, S.A.; Lain, P.J. *Transactions of the American Nuclear Society (USA),* 59: 309 (1989). (CONF-890604–: Annual meeting of the American Nuclear Society, Atlanta, GA (USA), 4-8 Jun 1989).

In most nuclear plants, including Ginna, the feedwater flow is provided by venturi ΔP flowmeters. Unfortunately, at some nuclear plants it is known that these meters have a tendency to foul, which causes them to indicate a higher flow than actually exists. In the early 1980s, a performance trend analysis by Rochester Gas and Electric (RG&E) indicated a small but significant degradation of power output a few months into each operating cycle following a refueling or maintenance outage. Investigation of plant major components, which included primary and secondary heat balances and main unit testing, led RG&E to suspect that both of the feedwater venturi meters were experiencing fouling, adversely affecting the calorimetric calculations and driving the 100% reactor power level downward. To overcome this problem and recover the lost power resulting from the erroneous venturi flow measurement, a leading edge flowmeter (LEFM) acoustic flow measurement system purchased from Westinghouse Electric Corp. was installed in 1986. Operation of the LEFM system soon confirmed the RG&E suspicions that venturi fouling was the source of the performance degradation at full-power operation.

40821 Computer-aided field inspection. Guillaume, E.; Lamarre, J.C. *Transactions of the American Nuclear Society (USA),* 59: 309-311 (1989). (CONF-890604–: Annual meeting of the American Nuclear Society, Atlanta, GA (USA), 4-8 Jun 1989).

This study evolved from the discovery that a number of incidents occurring in Electricite de France (EdF)-operated nuclear power plants were being caused by gradual degradation of the equipment's physical properties-a situation that had gone undetected, despite routine, day-to-day field inspections. A survey carried out subsequently at various plants showed that daily field inspection data were not always used to determine on-the-spot trends in equipment behavior, but more often to reconstruct these trends retrospectively, after the damage was done. From the period of reflection that followed, there emerged a new concept in EdF field inspection procedures. To ensure that work done by the field operator in performing inspections would be better reflected in plant results, it was decided to analyze field data immediately after it was recorded, instead of waiting for incidents to take place. In this way, the field operator could detect any changes in equipment properties and ultimately prevent equipment from deteriorating.

40822 Use of a remotely operated vehicle (submarine) for nuclear plant inspections. Duink, S.S.; Adam, J.D. *Transactions of the American Nuclear Society (USA),* 59: 313 (1989). (CONF-890604–: Annual meeting of the American Nuclear Society, Atlanta, GA (USA), 4-8 Jun 1989).

This paper describes the use of a specialized remotely operated vehicle (ROV) to perform visual underwater inspections in nuclear power plants. An underwater ROV, or minisubmarine, for visual inspections has several advantages over the more traditional camera-on-a-pole techniques and can perform some inspections easily that in the past were considered too difficult to conduct remotely. Other advantages include radiation does savings, outage critical path savings, and reduced manpower and expenses.

40823 Investigation of the control rod material presence in the Three Mile Island-2 lower head. Haghighat, A. *Transactions of the American Nuclear Society (USA),* 59: 348-350 (1989). (CONF-890604–: Annual meeting of the American Nuclear Society, Atlanta, GA (USA), 4-8 Jun 1989).

This paper is a follow-up study on the determination of the material distribution in the Three Mile Island Unit 2 (TMI-2) lower head. In a previous study, the authors analyzed the data obtained by a gamma detector inserted in the L-11 guide tube of the TMI-2 reactor lower head. The detector response was computed based on the adjoint function concept. The present study complements the previous study and suggests that it is reasonable to expect that there is a layer of CR materials at the bottom of the TMI-2 lower head in the vicinity of the L-11 guide tube. This conclusion is in agreement with the previous studies, which were based on other types of analyses.

40824 Simulation of a loss of coolant accident: Results of a standard problem exercise of the International Atomic Energy Agency. Sloan, S.M. (Texas A & M Univ., College Station (USA)); Hassan, Y. *Transactions of the American Nuclear Society (USA),* 59: 356 (1989). (CONF-890604–: Annual meeting of the American Nuclear Society, Atlanta, GA (USA), 4-8 Jun 1989).

The purpose of this study was to compare the results generated from the IBM version of RELAP5/MOD2 to the experimental data of an International Atomic Energy Agency (IAEA) standard problem exercise. The standard problem exercise data were that of a 7.4% break loss-of-coolant accident conducted at a test facility in Hungary. The United States did not formally participate in this exercise whose aim was to assess the capabilities of computer codes and modeling techniques and in which a total of 17 organizations from 12 countries participated. The results obtained using the IBM version of RELAP5/MOD2 compared favorably with the experimental data. The experimental facility, PMK-NVH (Paks Model Circuit), is a scaled-down model of a Hungarian reactor, the VVER-440 Paks nuclear power plant. A volume and power scaling ratio of 1:2070 is used. The six loops of the actual reactor are modeled by one active loop called the PMK. The secondary loop in the experimental facility is the NVH loop. The coolant in the facility is water, and the operating conditions are the same as in the actual reactor. The orientation of the steam generator is horizontal, as opposed to the vertical design of once-through and U-tube steam generators. The parameters of the accident are that it starts at full power, a 3-mm cold-side break occurs at the upper head of the downcomer, there is no injection from hydroaccumulators, the high-pressure injection

system corresponds to the case in which one-third of the pumps are available, and isolation of the secondary occurs immediately after transient initiation.

40825 On the prediction of flooding and associated phenomena. Sami, S.M. *Transactions of the American Nuclear Society (USA),* 59: 365-366 (1989). (CONF-890604–: Annual meeting of the American Nuclear Society, Atlanta, GA (USA), 4-8 Jun 1989).

Of particular importance is the countercurrent flow limitation phenomena (flooding) during a postulated loss-of-coolant accident of a pressurized water reactor or a boiling water reactor. A substantial number of studies have been reported in the literature on the basic mechanisms of flooding. Many of these studies were experimental, and only a few analytical models were presented. Despite these efforts, our understanding of the flooding phenomena and its mechanisms is inadequate. In this paper, the flooding phenomena are predicted by a multifluid model developed by Sami, and the numerical results are compared with available experimental ones.

40826 Some insights on the modification and design control process. Shulman, M.N.; Steinert, L. *Transactions of the American Nuclear Society (USA),* 59: 300-301 (1989). (CONF-890604–: Annual meeting of the American Nuclear Society, Atlanta, GA (USA), 4-8 Jun 1989).

The nuclear industry is placing substantially more emphasis on the modification and design control (MDC) process. This is reflected by regulatory emphasis through safety system functional inspections and other special inspections as well as industry programs to improve their modification and design control process. One such effort was embarked upon by the 16-member Nuclear Construction Issues Group (NCIG) and the Electric Power Research Institute. The effort identified generic problems relating to modification activities, determined where those problems occur in the MDC process, identified the causes of the problems, and provided guidance to prevent such problems in the future. This paper focuses on the question of how utilities are considering changing the way in which they do business to improve the modification process. In addition, it offers some insight on several of the problem areas identified with maintenance or improvement of safety margins.

40827 Maintaining plant safety margins. Bergeron, P.A. *Transactions of the American Nuclear Society (USA),* 59: 303-304 (1989). (CONF-890604–: Annual meeting of the American Nuclear Society, Atlanta, GA (USA), 4-8 Jun 1989).

The Final Safety Analysis Report Forms the basis of demonstrating that the plant can operate safely and meet all applicable acceptance criteria. In order to assure that this continues through each operating cycle, the safety analysis is reexamined for each reload core. Operating limits are set for each reload core to assure that safety limits and applicable acceptance criteria are not exceeded for postulated events within the design basis. These operating limits form the basis for plant operation, providing barriers on various measurable parameters. The barriers are refereed to as limiting conditions for operation (LCO). The operating limits, being influenced by many factors, can change significantly from cycle to cycle. In order to be successful in demonstrating safe operation for each reload core (with adequate operating margin), it is necessary to continue to focus on ways to maintain/improve existing safety margins. Existing safety margins are a function of the plant type [boiling water reactor/pressurized water reactor (BWR/PWR)], nuclear system supply (NSSS) vendor, operating license date, core design features, plant design features, licensing history, and analytical methods used in the safety analysis. This paper summarizes the experience at Yankee Atomic Electric Company (YAEC) in its efforts to provide adequate operating margin for the plants that it supports.

24 POWER TRANSMISSION AND DISTRIBUTION

40828 (CRIE-W–89025) **Development of an expert system for estimating flashover of contaminated insulators.** Ito, H.; Fuziwara, J. Central Research Inst. of Electric Power Industry, Tokyo (Japan). Dec 1989. 37p. (In Japanese). Order Number DE90507844. Available from NTIS (US Sales Only), PC A03/MF A01.

This paper reports on an expert system for predicting the occurrence of flashover to insulators contaminated with sea salt. The relationship between minimum flashover voltage for an insulator and the density of salt on the surface of the insulator is graphycally established based on the data derived at two locations in Japan. Data on past flashover are analyzed in connection with meteorogical factors and the ratios of average flashover voltages to minimum ones are calculated in order to make it possible to give the estimate of flashover voltage in any weather condition. Provided with these data base, the present system is constructed to predict the occurrence of flashover in response to the input data consisting of the density of salt on insulators, weather conditions and others. Based on sixty one data of good quality, it is shown that flashover voltages estimated by use of this system are on average about 7% in error as compared with actual values. 5 refs., 12 figs., 8 tabs.

2402 Power System Networks, Transmission and Distribution

40829 (CONF-900773–3) **On the vulnerability of electric power to geomagnetic storms.** Barnes, P.R.; Van Dyke, J.W. Oak Ridge National Lab., TN (USA). May 1990. 8p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC05-84OR21400. From IEEE/PES 1990 summer meeting; Minneapolis, MN (USA); 15-20 Jul 1990. Order Number DE90013929. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Geomagnetic storms associated with sunspot and solar flare activity can disturb communications and disrupt electric power. A severe geomagnetic storm could cause a major blackout with an economic impact of several billion dollars. The vulnerability of electric power systems in the northeast United States will likely increase during the 1990's due to the trend of wheeling large amounts of power over long distances to meet the electricity demands of this region. A comprehensive research program and a warning satellite to monitor the solar wind are needed to enhance the reliability of electric power systems under the influence of geomagnetic storms. 7 refs., 1 fig., 1 tab.

40830 The transformer. Coltman, J.W. *Scientific American (USA),* 258(1): 86-95 (Jan 1988).

The transformer is an essential component of modern electric power systems. It converts electricity with a low current and a high voltage into electricity with a high current and a low voltage (or vice versa) with almost no loss of energy. This paper reviews the history of the development of the transformer from Faraday's experiments in 1831 to the modern-day oil-cooled version. A brief forecast is made of its future development.

2403 Power Transmission Lines and Cables

40831 (AD-A–219975/0/XAB) **Theory of magnetically insulated electron flows in coaxial pulsed power transmission lines.** Lawconnell, R.I.; Neri, J. Frank J. Seiler Research Lab., United States Air Force Academy, CO (USA). Mar 1990. 13p. (FJSRL-JR–90-0005). Available from NTIS, PC A03/MF A01.

Pub. in Phys. Fluids B, Vol. 2, No. 3, 629-639(Mar 1990).

The Cartesian magnetically insulated transmission line (MITL) theory is extended to cylindrical coordinates. A set of equations that describe arbitrary electron flows in cylindrical coordinates is presented. These equations are used to derive a general theory for laminar magnetically insulated electron flows. The laminar theory allows one to specify the potentials, fields, and densities across a coaxial line undergoing explosive electron emission at the cathode. The theory is different from others available in cylindrical coordinates in that the canonical momentum and total energy for each electron may be nonzero across the electron sheath. A nonzero canonical momentum and total energy for the electrons in the sheath allows the model to produce one-dimensional flows that resemble flows from lines with impedance mismatches and perturbing structures. The laminar theory is used to derive two new self-consistent cylindrical flow solutions: (1) for a constant density profile and (2) for a quadratic density profile of the form p = p sub

c ((r-sq sub m-r-sq)/(r-sq sub m-r-sq sub c)). This profile is of interest in that it is similar to profiles observed in a long MITL simulation. The theoretical flows are compared to numerical results obtained with 2-D electromagnetic particle-in-cell codes.

40832 (CRIE-W–89002) **Evaluation of long-term insulation performances of EHV XLPE cable by a high frequency acceleration test.** Suzuki, H.; Fukagawa, H.; Okamoto, T.; Ishida, M. Central Research Inst. of Electric Power Industry, Tokyo (Japan). Nov 1989. 38p. (In Japanese). Order Number DE90507840. Available from NTIS (US Sales Only), PC A03/MF A01.

Extra high voltage class XLPE (cross-linked polythylene insulated) cables were put to high frequency acceleration test in order to examined if the long-term insulation quality of the eables might be affected by the growth of bow-tie trees in the interior of their insulation layers. Test samples 100m long, equivalent in quality to 66kV class power calbes in common use, were kept under the application of high frequency voltage of 1kHz and 63kV for 13,164 hours, thus potential gradient inside the insulation layer 9mm thick being kept at 7kV/mm on average, while the temperature of their inner conductor was raised to about 65 or 75 cntigrade and dropped to ordinary temperature cyclically once a day. It was confirmed by this test that the growth of bow-tie tress, the maximum length of them being 200 μ m, did not cause insulation deterioration to the test samples. A brief description is given of a marked change produced by this test in microstructures of insulating materials, such as crystalline lamellas of polyethylene. 11 refs., 16 figs., 11 tabs.

40833 (CRIE-W–89019) **Development of compacted transmission lines.** Takahashi, T.; Taniguchi, T.; Watanabe, Y. Central Research Inst. of Electric Power Industry, Tokyo (Japan). Jan 1990. 40p. (In Japanese). Order Number DE90507886. Available from NTIS (US Sales Only), PC A03/MF A01.

It is expected that demand for electric power in city periphery is increasing in future, and the construction of transmission lines for the demand is of great importance. Then a fundamental idea of developing compact transmission lines in the 66kV class which are harmonized with the environment of city periphery also of intending to decrease their construction cost, is presented in this paper. Simultaneously the strength required to the polymer insulators to be applied to these lines, was studied. About the compact transmission lines, iron tower of single pole type with steel pipes was employed in power transmission line tower, and line post insulator together with line spacer were adopted into insulators. As the result, the tower was able to decrease six-meter in its height and 2.6-meter in its two-ciecuit line distance as shorter than those of the conventional tower. Line post insulator and line spacer which require high strength and light weight were polymer compsite insulator covered by the material wrapped in silicone rubber on FRP core. According to the estimation of the load on post insulator and line spacer which were calculated by the load on actual lines, there is a prospect of complete success in manufacturing the insulators with durable strength for estimated load. 7 refs., 16 figs., 13 tabs.

40834 (CRIE-W–89023) **Development of separable compact joints for 6.6kV cables and equipments.** Ito, T.; Imajo, T.; Chino, T.; Suzuki, S. Central Research Inst. of Electric Power Industry, Tokyo (Japan). Feb 1990. 33p. (In Japanese). Order Number DE90507885. Available from NTIS (US Sales Only), PC A03/MF A01.

It is necessary to reduce sizes of equipments and handholes housing these equipments to reduce the underground distribution cost. As a part of the measures, separatable compact high voltage joints which are used to connect each other or between joints and equipments, were developed. The compact joint for 6.6kV developed this time, is composed of juction (three branches) and inserting elbow. Compact size elbow was modified for louver fins from single to twin type to prevent the reduction of contact area and spring strength was improved. Minimum insulation thickness was reduced from 8mm to 5mm, enabling the reduction of the conductor destance to 2/3 and overall shape to 3/4. Initial insulating and conducting performances in the connected condition were execellent. After the installation test, it was proved that the volume inside the handhole could be reduced to 2m ^{3} which corresponed to 1/4 to 1/5 of the conventional type, enabling the installation of underground distribution for shallow footway like 3.5m width for which the installation was previously impossible. 4 refs., 13 figs., 8 tabs.

40835 (CRIE-W–89024) **Application of polymer insulating materials for surge arrester housing.: Development of gapless-type polymer arresters for 22kV class distribution lines.** Taniguchi, T.; Izumi, K.; Takaseki, M.; Kimura, J.; Keira, T. Central Research Inst. of Electric Power Industry, Tokyo (Japan). Dec 1989. 45p. (In Japanese). Order Number DE90507843. Available from NTIS (US Sales Only), PC A03/MF A01.

This paper reports on arresters made on an experimental basis for use on 22kV clasas and 6.6kV class distribution lines by making use of polymer insulating materials for their housings in order to reduce their size and weight. As the principal part of the arrester a number of zinc oxide elements in a pile are kept inside a cylindrical case made of FRP (fibre reinforced plastics) . This FRP case is tightly covered from the outside with a polymer tube, namely a housing, made of modified silicone rubber or modified ethylene vinyl acetate. This arrester is about one third in weight and reduces the cost by 20% as compared with a porcelain housing arrester so far in use. Test samples of the arrester were put to laboratory tests as follows; pressure relief test by applying large short-circuit current, withstand voltage test in mist with an amount of salt coated on them, and airtightness test under various conditions. It is shown that they stand these tests fairly well, in particular do not burst without providing any special relief unit though the applied short-circuit current cause the internal part of them to break down. 16 refs., 21 figs., 12 tabs.

40836 (EPRI-EL–6420-Vol.8) **TLWorkstation™ code: Version 2.0: Volume 8, DYNAMP [DYNamic AMPacity] manual: Final report.** Black, W.Z. (Georgia Inst. of Tech., Atlanta, GA (USA). School of Mechanical Engineering). Electric Power Research Inst., Palo Alto, CA (USA); Georgia Inst. of Tech., Atlanta, GA (USA). School of Mechanical Engineering. ©Jun 1990. 56p. Sponsored by Electric Power Research Institute. Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

DYNAMP can perform both steady-state and transient ampacity calculations. There are four program options. The first program option involves a steady-state model which calculates a single value of the conductor temperature for constant weather conditions and a constant line current. The program also calculates ampacity for a given value of conductor limiting temperature. This type of model has been traditionally referred to as the House and Tuttle method. The second program option consists of a transient model for real-time conductor operation and it calculates instantaneous conductor temperatures when the conductor experiences varying current level and weather conditions. The third program option provides predictive temperature calculations based on emergency situations that can arise from a sudden current overload on the line. The fourth program option predicts the allowable overload current that can be sustained for a given time and not exceed the limiting temperature.

40837 (EPRI-EL–6420-Vol.17) **TLWorkstation™ code: Version 2.0: Volume 17, MFAD [Moment Foundation Analysis and Design] manual: Final report.** Bragg, R.A. (GIA Consultants, Inc., Monroeville, PA (USA)); DiGiogia, A.M. Jr.; Rojas-Gonzalez, L.R. Electric Power Research Inst., Palo Alto, CA (USA); GIA Consultants, Inc., Monroeville, PA (USA). ©Jun 1990. 52p. Sponsored by Electric Power Research Institute. Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

This document constitutes a user's manual for the computer program MFAD (Moment Foundation Analysis and Design). MFAD was derived from the earlier computer program PADLL (Pier Analysis and Design for Lateral Loads), which was developed in conjunction with the Electric Power Research Institute (EPRI) Project 1280-1 (Laterally Loaded Drilled Pier Research) and Sandia National Laboratories Contract 20-4441. PADLL was modified to produce MFAD by incorporating analysis/design capabilities into the program to consider direct embedment foundations based on the results of research conducted under EPRI Project 1280-3 (Development of a Direct Embedment Foundation Design Procedure) and Empire State Electric Energy Research Corporation (ESEERCO) Project EP85-33. Existing methodologies for design and analysis of drilled shafts and direct embedment foundations subjected to overturning

moments were reviewed and critiqued, and improved theoretical models for ultimate lateral capacity and nonlinear load-deflection response were developed. These theoretical models were incorporated into a nonlinear load-deflection response were developed. These theoretical models were incorporated into a nonlinear load-deflection and ultimate capacity model, which was subsequently modified to obtain a semi-empirical model that provides a best-fit to the test results from prototype drilled shaft and direct embedment foundation tests. The computer program (MFAD) based on this semi-empirical model is described. The program has geotechnical design and analysis capabilities for laterally loaded drilled shafts and direct embedment foundations embedded in multilayered soil profiles. Documentation for the development of the computer program and the prototype foundation load testing programs conducted in EPRI Projects RP 1280-1 and 1280-3 is contained in EPRI Reports EL 2197, Volumes 1 and 2, and EL-6309.

40838 (EPRI-EL–6859) **Impurities in extruded cables: A proton-induced x-ray emission diagnostic study: Final report.** Crine, J.P. (Institut de Recherche d'Hydro-Quebec, Varennes, PQ (Canada)); Hinrichsen, P.F.; Houdayer, A. Electric Power Research Inst., Palo Alto, CA (USA); Institut de Recherche d'Hydro-Quebec, Varennes, PQ (Canada). ©Jun 1990. 55p. Sponsored by Electric Power Research Institute. Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

The impurity contents and distributions in electrical trees grown in various field-aged XLPE distribution cables were measured by micro-Proton Induced X-ray Emission (PIXE). The objectives pursued in this preliminary study were the following. Determination of any possible correlation between electrical tree initiation and the nature of some specific impurities. Evaluation of micro-PIXE as a reliable analytical technique to measure impurities in localized defects, such as small trees. For that purpose we used the micro-PIXE facility of the Laboratoire de Physique Nucleaire at University of Montreal where proton beams of ≈20 microns can be focused on small samples. From the emitted x-rays, it is possible to determine the nature and content of most impurities (whose content is above ≈1 ppM). Cable samples with electrical trees grown either from insulation shield or from water trees were analyzed. A few field-aged cable samples containing breakdown channels of various sizes were also analyzed. The aim here was to determine whether impurities could still be detected after breakdown. The observations made can be summarized as follows: the electrical trees studied were heavily contaminated by a wide variety of impurities; electrical trees contain the same impurities as the connecting water trees and the amounts are about the same in both types of trees; provided that the energy released during breakdown is not too high, that is as long as breakdown channels remain small; the minimum level of contamination leading to tree growth is difficult to ascertain; no clear correlation can be established between the nature of impurities and electrical tree initiation; it cannot be determined whether contamination leads to tree initiation or whether contamination follows tree growth; and micro-PIXE is well suited to study impurities in electrical (and water) trees. 20 refs., 18 figs., 8 tabs.

2405 Environmental Aspects

Refer also to citation(s) 40836

25 ENERGY STORAGE

2504 Capacitor Banks

40839 (N–90-20454, pp. 83-94) **Advanced double layer capacitors.** Sarangapani, S.; Lessner, P.; Forchione, J.; Griffith, A.; Laconti, A.B. National Aeronautics and Space Administration, Cleveland, OH (USA). Lewis Research Center. Dec 1989. (NASA-CP–3056;E–4708;NAS–1.55:3056;CONF-8904196–: 2. space electrochemical research and technology conference, Cleveland, OH (USA), 11-13 Apr 1989). In *Space electrochemical research and technology (SERT), 1989.* Available from NTIS, PC A16/MF A02.

Work was conducted that could lead to a high energy density electrochemical capacitor, completely free of liquid electrolyte. A three-dimensional RuO sub x-ionomer composite structure has been successfully formed and appears to provide an ionomer ionic linkage throughout the composite structure. Capacitance values of approximately 0.6 F/sq cm were obtained compared with 1 F/sq cm when a liquid electrolyte is used with the same configuration.

2509 Batteries

Refer also to citation(s) 40890, 40953

40840 (AD-A–219822/4/XAB) **New liquid cathode electrolytes in high-rate cells. Interim technical report.** Bailey, J.W.; Kalisz, D.M.; Blomgren, G.E. Eveready Battery Co., Inc., Westlake, OH (USA). Technology Lab. 15 Mar 1990. 29p. (TR–1). Available from NTIS, PC A03/MF A01.

The power limitations of liquid oxyhalide batteries have been explored by examining the physical and electrical properties of new electrolytes. Conductivity, kinematic viscosity and specific gravity of electrolytes were measured inside a specially adapted argon filled drybox. Liquid cathode oxyhalide electrolytes designed to enhance power density were tested first in demountable test cells and then, the most promising, in hermetically sealed high rate F size jellyroll cells. For F cells, the capacity on constant current discharge was measured at 3.5 and 12.5 mA/cm2 for fresh cells at 21 C and at 3.5 mA/cm2 for cells stored 4 weeks at 54 C then discharged at -30 C. An optimized cell design with thicker electrodes was developed for testing electrolytes with higher conductivity than LiAlCl4-SOCl2. The best capacity at 2A was achieved with LiGaCl4-SOCl2 or LiAlCl4-SOCl2. The best capacity at 7A was achieved with LiGaCl4-SOCl2. LiGaCl4 in SOCl2 was found to discharge at higher temperatures than LiAlCl4 in SOCl2. Imidazolium, aralkylammonium and sulfonium chlorides were found to have high solubility and conductivity in thionyl chloride, but lithium was found to be passive in contact with these solutions and most metals corroded excessively. These salts mixed with aluminum chloride were much less aggressive and when mixed with lithium salts in addition gave high conductivity and test cell capacities. In finished cells, however, the solutions were still too corrosive to make stable systems.

40841 (AD-A–219823/2/XAB) **Effect of carbon type and processing on high-rate thionyl chloride cathode collectors. Interim technical report.** Bailey, J.C.; Kalisz, D.W.; Blomgren, G.E. Eveready Battery Co., Inc., Westlake, OH (USA). Technology Lab. 20 Mar 1990. 35p. (TR–2). Available from NTIS, PC A03/MF A01.

This study was initiated to determine the effects of carbon type, treatment and additives and the manufacturing process on high rate performance of thionyl chloride cathode collectors. Seventeen different collector materials and treatments were tested in demountable test cells and the results compared on the basis of capacity and energy per unit void volume of the cathode collector. Superior results were consistently obtained from CoTMPP catalyzed carbons and from carbon microfibers. Better voltage results were obtained from Ketjenblack EC, but the capacity was not consistently better than acetylene black. Process conditions did not show strong correlations, but in some cases there appears to be a best process for a given carbon type. A significant high rate (7 A test) capacity improvement was seen in F cells with a carbon fiber electrode in agreement with test cell results. Other test cells results did not correlate well with F cell tests, but further work is required to establish statistical significance.

40842 (CONF-900801–19) **Development of a sealed bipolar Li-alloy/FeS_2 battery for electric vehicles.** Kaun, T.D.; Duoba, M.J.; Gillie, K.R.; Hash, M.C.; Simon, D.R.; Vissers, D.R. Argonne National Lab., IL (USA). [1990]. 7p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract W-31109-ENG-38. From 25. intersociety energy conversion engineering conference; Reno, NV (USA); 12-17 Aug 1990. Order Number DE90013650. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Rapid progress is being made in the development of a bipolar Li-alloy/FeS_2 battery with molten LiCl-LiBr-KBr electrolyte and MgO powder separator. Such a battery would be operated at 400-425°C and is expected to attain high performance and long cycle

life (>1000 cycles). An overcharge tolerant cell design safeguards the Li-alloys/FeS_2 cells in the bipolar battery ad allows charge equalization with simple trickle charging. New ceramic materials have been developed for use as the peripheral hermetic seals required for electrolyte containment in bipolar cells. A stack of four bipolar Li-alloy/FeS_2 cells with these seals has been operated for over 150 cycles. Projected performance for a prototype sealed bipolar Li-alloy/FeS_2 battery is 191 Wh/kg specific energy and 500 W/kg peak specific power through 80% depth of discharge. Outstanding electric-vehicle performance can be expected from such a battery. 9 refs., 8 figs.

40843 (CONF-900801–20) **Life evaluation of valve regulated lead-acid batteries for cycling applications.** DeLuca, W.H.; Tummillo, A.F.; Webster, C.E.; Hogrefe, R.L.; Miller, J.F. Argonne National Lab., IL (USA). [1990]. 6p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract W-31109-ENG-38. From 25. intersociety energy conversion engineering conference; Reno, NV (USA); 12-17 Aug 1990. Order Number DE90013649. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Argonne National Laboratory (ANL) is conducting a life evaluation of valve-regulated lead-acid (VRLA) batteries for cycling applications. Two technologies are being evaluated: (1) gelled-electrolyte modules from Johnson Controls, Inc. (JCI) and (2) absorbed electrolyte modules from GNB, Inc. A matrix of operating temperature and depth-of-discharge (DOD) conditions is being used to accelerate in the end-of-life for given modules. In May 1989, two modules from each manufacturer were placed on life test at 30°C (80 and 100% DOD), and third module was placed on accelerated life testing at 50°C (100% DOD). The GNB module operating to 100% DOD at 30°C still retains ~87% of its initial capacity after~470 cycles. The GNB module operating to 80% DOD at 30°C has accrued ~600 cycles and retains ~92% of its initial 80% DOD capacity. After a high-temperature charge procedure was established, a fourth GNB module was placed on test at 50°C (80% DOD) in September 1989. Both GNB modules tested at 50°C have accrued ~170 cycles; the 100% DOD module retains ~84% of its initial capacity, and the 80% DOD module retains ~89% of its initial 80% DOD capacity. Only one of the gelled-electrolyte JCI modules remains on test (30°C, 80% DOD). It retains ~86% of its initial 80% DOD capacity after >450 cycles. The other two JCI modules were removed from test because they reached end-of-life. Teardown analyses at JCI indicate that a manufacturing defect caused premature failure of one module. The second module is undergoing teardown analyses at ANL. 2 refs., 5 figs., 5 tabs.

40844 (CONF-900801–21) **Performance evaluation of advanced battery technologies for electric vehicle applications.** DeLuca, W.H.; Tummillo, A.F.; Kulaga, J.E.; Webster, C.E.; Gillie, K.R.; Hogrefe, R.L. Argonne National Lab., IL (USA). [1990]. 6p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract W-31109-ENG-38. From 25. intersociety energy conversion engineering conference; Reno, NV (USA); 12-17 Aug 1990. Order Number DE90013895. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

At the Argonne Analysis & Diagnostic Laboratory, advanced battery technology evaluations are performed under simulated electric vehicle operating conditions. During 1989 and the first quarter of 1990, single cell and multicell modules from seven developers were examined for the Department of Energy and Electric Power Research Institute. The results provide battery users, developers, and program managers with an interim measure of the progress being made in battery R&D programs, a comparison of battery technologies, and a source of basic data for modeling and continuing R&D. This paper summarizes the performance and life characterizations of two single cells and seven 3- to 960-cell modules that encompass six technologies (Na/S, Ni/Fe, Ni/Cd, Ni-metal hydride, lead-acid, and Zn/Br). 4 figs., 2 tabs.

40845 (N–90-19390, pp. 23) **Frequency response of electrochemical cells.** Thomas, D.L. Alabama Univ., Huntsville, AL (USA). Dec 1989. (NASA-CR–183837;NAS–1.26:183837;CONF-8906334–: 1989 NASA/ASEE summer faculty fellowship program, Huntsville, AL (USA), 5 Jun 1989). In *Research reports: 1989 NASA/ASEE Summer faculty fellowship program.* Available from NTIS, PC A99/MF E06.

Impedance concepts can be applied to the analysis of battery electrodes, yielding information about the structure of the electrode and the processes occurring in the electrode. Structural parameters such as the specific area (surface area per gram of electrode) can be estimated. Electrode variables such as surface overpotential, ohmic losses, and diffusion limitations may be studied. Nickel and cadmium electrodes were studied by measuring the ac impedance as a function of frequency, and the specific areas that were determined were well within the range of specific areas determined from BET measurements. Impedance spectra were measured for the nickel and cadmium electrodes, and for a 20 A-hr NiCd battery as functions of the state of charge. More work is needed to determine the feasibility of using frequency response as a nondestructive testing technique for batteries.

40846 (N–90-20454) **Space electrochemical research and technology (SERT), 1989.** Baldwin, R.S. National Aeronautics and Space Administration, Cleveland, OH (USA). Lewis Research Center. Dec 1989. 351p. (NASA-CP–3056;E–4708;NAS–1.55:3056;CONF-8904196–: 2. space electrochemical research and technology conference, Cleveland, OH (USA), 11-13 Apr 1989). Available from NTIS, PC A16/MF A02.

The proceedings of NASA's second Space Electrochemical Research and Technology Conference are presented. The objectives of the conference were to examine current technologies, research efforts, and advanced ideas, and to identify technical barriers which affect the advancement of electrochemical energy storage systems for space applications. The conference provided a forum for the exchange of ideas and opinions of those actively involved in the field, with the intention of coalescing views and findings into conclusions on progress in the field, prospects for future advances, areas overlooked, and the directions of future efforts. Related overviews were presented in the areas of NASA advanced mission models. Papers were presented and workshops conducted in four technical areas: advanced concepts, hydrogen-oxygen fuel cells and electrolyzers, the nickel electrode, and advanced rechargable batteries.

40847 (N–90-20454, pp. 1-3) **Overview of battery usage in NASA/GSFC LEO and GEOspacecrafts.** Yi, T.Y. National Aeronautics and Space Administration, Cleveland, OH (USA). Lewis Research Center. Dec 1989. (NASA-CP–3056;E–4708;NAS–1.55:3056;CONF-8904196–: 2. space electrochemical research and technology conference, Cleveland, OH (USA), 11-13 Apr 1989). In *Space electrochemical research and technology (SERT), 1989.* Available from NTIS, PC A16/MF A02.

A survey of the batteries used in the low earth orbit (LEO) and geosynchronous earth orbit (GEO) missions at the Goddard Space Flight Center is described. For each spacecraft, tentative launch date is given, along with relevant battery parameters including battery size and description, depth-of-discharge, predicted mission temperature, and life requirement.

40848 (N–90-20454, pp. 5-8) **The importance of batteries in unmanned missions.** Klein, J.W. National Aeronautics and Space Administration, Cleveland, OH (USA). Lewis Research Center. Dec 1989. (NASA-CP–3056;E–4708;NAS–1.55:3056;CONF-8904196–: 2. space electrochemical research and technology conference, Cleveland, OH (USA), 11-13 Apr 1989). In *Space electrochemical research and technology (SERT), 1989.* Available from NTIS, PC A16/MF A02.

The planetary program has historically used batteries to supply peak power needs for mission specific applications. Any time that additional power has been required in order to meet peak power demands or those applications where only limited amounts of power were required, batteries have always been used. Up until the mid to late 70's they have performed their task admirably. Recently, however, we have all become aware of the growing problem of developing reliable NiCd batteries for long mission and high cycle life applications. Here, the role rechargeable batteries will play for future planetary and earth observing spacecraft is discussed. In conclusion, NiCds have been and will continue to be the mainstay of the power system engineers tools for peak power production. Recent experience has tarnished its once sterling reputation. However, the industry has stood up to this challenge and implemented wide ranging plans to rectify the situation. These efforts should be applauded and supported as new designs and

materials become available. In addition, project managers must become aware of their responsibility to test their batteries and insure quality and mission operating characteristics. Without this teamwork, the role of NiCds in the future will diminish, and other batteries, not as optimum for high performance applications (low mass and volume) will take their place.

40849 (N–90-20454, pp. 17-32) **A survey of advanced battery systems for space applications.** Attia, A.I. National Aeronautics and Space Administration, Cleveland, OH (USA). Lewis Research Center. Dec 1989. (NASA-CP–3056;E–4708;NAS–1.55:3056;CONF-8904196–: 2. space electrochemical research and technology conference, Cleveland, OH (USA), 11-13 Apr 1989). In *Space electrochemical research and technology (SERT), 1989.* Available from NTIS, PC A16/MF A02.

The results of a survey on advanced secondary battery systems for space applications are presented. Fifty-five battery experts from government, industry and universities participated in the survey by providing their opinions on the use of several battery types for six space missions, and their predictions of likely technological advances that would impact the development of these batteries. The results of the survey predict that only four battery types are likely to exceed a specific energy of 150 Wh/kg and meet the safety and reliability requirements for space applications within the next 15 years.

40850 (N–90-20454, pp. 33-39) **Advanced rechargeable sodium batteries with novel cathodes.** Distefano, S.; Ratnakumar, B.V.; Bankston, C.P. National Aeronautics and Space Administration, Cleveland, OH (USA). Lewis Research Center. Dec 1989. (NASA-CP–3056;E–4708;NAS–1.55:3056;CONF-8904196–: 2. space electrochemical research and technology conference, Cleveland, OH (USA), 11-13 Apr 1989). In *Space electrochemical research and technology (SERT), 1989.* Available from NTIS, PC A16/MF A02.

Various high energy density rechargeable batteries are being considered for future space applications. Of these, the sodium sulfur battery is one of the leading candidates. The primary advantage is the high energy density (760 Wh/kg theoretical). Energy densities in excess of 180 Wh/kg have been realized in practical batteries. More recently, cathodes other than sulfur are being evaluated. Researchers at JPL are evaluating various new cathode materials for use in high energy density sodium batteries for advanced space applications. The approach is to carry out basic electrochemical studies of these materials in a sodium cell configuration in order to understand their fundamental behaviors. Thus far studies have focused on alternate metal chlorides such as CuCl2 and organic cathode materials such as tetracyanoethylene (TCNE).

40851 (N–90-20454, pp. 61-68) **A new concept for high-cycle-life LEO: Rechargeable MnO2-hydrogen.** Appleby, A.J.; Dhar, H.P.; Kim, Y.J.; Murphy, O.J. National Aeronautics and Space Administration, Cleveland, OH (USA). Lewis Research Center. Dec 1989. (NASA-CP–3056;E–4708;NAS–1.55:3056;CONF-8904196–: 2. space electrochemical research and technology conference, Cleveland, OH (USA), 11-13 Apr 1989). In *Space electrochemical research and technology (SERT), 1989.* Available from NTIS, PC A16/MF A02.

The nickel-hydrogen secondary battery system, developed in the early 1970s, has become the system of choice for geostationary earth orbit (GEO) applications. However, for low earth orbit (LEO) satellites with long expected lifetimes the nickel positive limits performance. This requires derating of the cell to achieve very long cycle life. A new system, rechargeable MnO2-Hydrogen, which does not require derating, is described here. For LEO applications, it promises to have longer cycle life, high rate capability, a higher effective energy density, and much lower self-discharge behavior than those of the nickel-hydrogen system.

40852 (N–90-20454, pp. 69-82) **Characterization testing of a 40 AHR bipolar nickel-hydrogen battery.** Brewer, J.C. (National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL (USA)); Manzo, M.A.; Gemeiner, R.P. National Aeronautics and Space Administration, Cleveland, OH (USA). Lewis Research Center. Dec 1989. (NASA-CP–3056;E–4708;NAS–1.55:3056;CONF-8904196–: 2. space electrochemical research and technology conference, Cleveland, OH (USA), 11-13 Apr 1989). In *Space electrochemical research and technology (SERT), 1989.* Available from NTIS, PC A16/MF A02.

Extensive characterization testing has been done on a second 40 amp-hour (Ahr), 10-cell bipolar nickel-hydrogen (Ni-H2) battery to study the effects of such operating parameters as charge and discharge rates, temperature, and pressure, on capacity, Ahr and watt-hour (Whr) efficiencies, end-of-charge (EOC) and mid-point discharge voltages. Testing to date has produced many interesting results, with the battery performing well throughout all of the test matrix except during the high-rate (5C and 10C) discharges, where poorer than expected results were observed. The exact cause of this poor performance is, as yet, unknown. Small scale 2 x 2 inch battery tests are to be used in studying this problem. Low earth orbit (LEO) cycle life testing at a 40 percent depth of discharge (DOD) and 10 C is scheduled to follow the characterization testing.

40853 (N–90-20454, pp. 32) **The application of electrochemical impedance spectroscopy for characterizing the degradation of Ni(OH)2/NiOOH electrodes.** MacDonald, D.D. (Ford Aerospace and Communications Corp., Palo Alto, CA (USA)); Pound, B.G.; Lenhart, S.J. National Aeronautics and Space Administration, Cleveland, OH (USA). Lewis Research Center. Dec 1989. (NASA-CP–3056;E–4708;NAS–1.55:3056;CONF-8904196–: 2. space electrochemical research and technology conference, Cleveland, OH (USA), 11-13 Apr 1989). In *Space electrochemical research and technology (SERT), 1989.* Available from NTIS, PC A16/MF A02.

Electrochemical impedance spectra of rolled and bonded and sintered porous nickel battery electrodes were recorded periodically during charge/discharge cycling in concentrated KOH solution at various temperatures. A transmission line model (TLM) was adopted to represent the impedance of the porous electrodes, and various model parameters were adjusted in a curve fitting routine to reproduce the experimental impedances. Degradation processes for rolled and bonded electrodes were deduced from changes in model parameters with electrode cycling time. In developing the TLM, impedance spectra of planar (non-porous) electrodes were used to represent the pore wall and backing plate interfacial impedances. These data were measured over a range of potentials and temperatures, and an equivalent circuit model was adopted to represent the planar electrode data. Cyclic voltammetry was used to study the characteristics of the oxygen evolution reaction on planar nickel electrodes during charging, since oxygen evolution can affect battery electrode charging efficiency and ultimately electrode cycle life if the overpotential for oxygen evolution is sufficiently low. Transmission line modeling results suggest that porous rolled and bonded nickel electrodes undergo restructuring during charge/discharge cycling prior to failure.

40854 (N–90-20454, pp. 15) **KOH concentration effect on the cycle life of nickel-hydrogen cells. Part 4: Results of failure analyses.** Lim, H.S.; Verzwyvelt, S.A. National Aeronautics and Space Administration, Cleveland, OH (USA). Lewis Research Center. Dec 1989. (NASA-CP–3056;E–4708;NAS–1.55:3056;CONF-8904196–: 2. space electrochemical research and technology conference, Cleveland, OH (USA), 11-13 Apr 1989). In *Space electrochemical research and technology (SERT), 1989.* Available from NTIS, PC A16/MF A02.

KOH concentration effects on cycle life of a Ni/H_2 cell have been studied by carrying out a cycle life test of ten Ni/H_2 boiler plate cells which contain electrolytes of various KOH concentrations. Failure analyses of these cells were carried out after completion of the life test which accumulated up to 40,000 cycles at an 80 percent depth of discharge over a period of 3.7 years. These failure analyses included studies on changes of electrical characteristics of test cells and component analyses after disassembly of the cell. The component analyses included visual inspections, dimensional changes, capacity measurements of nickel electrodes, scanning electron microscopy, BET surface area measurements, and chemical analyses. Results have indicated that failure mode and change in the nickel electrode varied as the concentration was varied, especially, when the concentration was changed from 31 percent or higher to 26 percent or lower.

40855 (N–90-20454, pp. 9) **Advances in lightweight nickel electrode technology.** Coates, D.; Paul, G.; Daugherty, P. National Aeronautics and Space Administration, Cleveland, OH (USA). Lewis Research Center. Dec 1989. (NASA-CP–3056;E–4708;NAS–1.55:3056;CONF-8904196–: 2. space electrochemical research and technology conference, Cleveland, OH (USA), 11-13 Apr 1989). In *Space electrochemical research and technology (SERT), 1989.* Available from NTIS, PC A16/MF A02.

Studies are currently underway to further the development of lightweight nickel electrode technology. Work is focused primarily on the space nickel-hydrogen system and nickel-iron system but is also applicable to the nickel-cadmium and nickel-zinc systems. The goal is to reduce electrode weight while maintaining or improving performance, thereby increasing electrode energy density. Two basic electrode structures are being investigated. The first is the traditional nickel sponge produced from sintered nickel-carbonyl powder. The second is a new material for this application which consists of a non-woven mat of nickel fiber. Electrodes are being manufactured, tested, and evaluated at the electrode and cell level.

40856 (N–90-20454, pp. 9) **Multi-mission Ni-H2 battery cells for the 1990's.** Miller, L.; Brill, J.; Dodson, G. National Aeronautics and Space Administration, Cleveland, OH (USA). Lewis Research Center. Dec 1989. (NASA-CP–3056;E–4708;NAS–1.55:3056;CONF-8904196–: 2. space electrochemical research and technology conference, Cleveland, OH (USA), 11-13 Apr 1989). In *Space electrochemical research and technology (SERT), 1989.* Available from NTIS, PC A16/MF A02.

A sufficient production, test and operational database is now available to permit design technology optimization for the next decade. The evolved battery cell design features standardized technology intended to support multiple type missions (e.g., both GEO and LEO). Design analysis and validation test cells demonstrate that improved performance plus attractive specific-energy characteristics will be achieved.

40857 (N–90-20454, pp. 10) **Sodium-sulfur battery flight experiment definition study.** Chang, R. (Ford Aerospace Corp., Newport Beach, CA (USA)); Minck, R. National Aeronautics and Space Administration, Cleveland, OH (USA). Lewis Research Center. Dec 1989. (NASA-CP–3056;E–4708;NAS–1.55:3056;CONF-8904196–: 2. space electrochemical research and technology conference, Cleveland, OH (USA), 11-13 Apr 1989). In *Space electrochemical research and technology (SERT), 1989.* Available from NTIS, PC A16/MF A02.

NaS batteries have been identified as the most likely successor to space Ni-H2 or Ni-Cd batteries, primarily due to a mass reduction by a factor 2 to 3 over Ni-H2 and by a factor of 4 over Ni-Cd. This yields major launch cost reductions or payload mass improvements. NaS batteries support NASA OAST's proposed Civil Space Technology Initiative goal of a factor of two improvement in spacecraft 2000 initiative. Since Ni-H2 and Ni-Cd batteries have been space flight proven, it is essential to have the flight experiment to establish a national space technology base to demonstrate the operation of the NaS battery for space applications.

40858 (N–90-20454, pp. 18) **Advanced high-temperature batteries.** Nelson, P.A. National Aeronautics and Space Administration, Cleveland, OH (USA). Lewis Research Center. Dec 1989. (NASA-CP–3056;E–4708;NAS–1.55:3056;CONF-8904196–: 2. space electrochemical research and technology conference, Cleveland, OH (USA), 11-13 Apr 1989). In *Space electrochemical research and technology (SERT), 1989.* Available from NTIS, PC A16/MF A02.

Recent results for Li-Al/FeS_2 cells and bipolar battery design have shown the possibility of achieving high specific energy (210 Wh/kg) and high specific power (239 W/kg) at the cell level for an electric vehicle application. Outstanding performance is also projected for sodium/metal chloride cells having large electrolyte areas and thin positive electrodes.

40859 (N–90-20454, pp. 14) **Advances in ambient temperature secondary lithium cells.** Subbarao, S.; Shen, D.H.; Deligiannis, F.; Huang, C.K.; Halpert, G. National Aeronautics and Space Administration, Cleveland, OH (USA). Lewis Research Center. Dec 1989. (NASA-CP–3056;E–4708;NAS–1.55:3056;CONF-8904196–: 2. space electrochemical research and technology conference, Cleveland, OH (USA), 11-13 Apr 1989). In *Space electrochemical research and technology (SERT), 1989.* Available from NTIS, PC A16/MF A02.

The goal is to develop secondary lithium cells with a 100 Wh/kg specific energy capable of 1000 cycles at 50 percent DOD. The approach towards meeting this goal initially focused on several basic issues related to the cell chemistry, selection of cathode materials and electrolytes and component development. The performance potential of Li-TiS_2, Li-MoS_3, Li-V_6O_{13} and Li-$NbSe_3$ electrochemical systems was examined. Among these four, the Li-TiS_2 system was found to be the most promising system in terms of achievable specific energy and cycle life. Major advancements to date in the development of Li-TiS_2 cells are in the areas of cathode processing technology, mixed solvent electrolytes, and cell assembly. A summary is given of these advances.

40860 (N–90-20454, pp. 197-209) **Impedance studies of Ni/Cd and Ni/H_2 cells using the cell case as a reference electrode.** Reid, M.A. National Aeronautics and Space Administration, Cleveland, OH (USA). Lewis Research Center. Dec 1989. (NASA-CP–3056;E–4708;NAS–1.55:3056;CONF-8904196–: 2. space electrochemical research and technology conference, Cleveland, OH (USA), 11-13 Apr 1989). In *Space electrochemical research and technology (SERT), 1989.* Available from NTIS, PC A16/MF A02.

Impedance measurements have been made on several Ni/Cd and Ni/H_2 flightweight cells using the case as a reference electrode. For these measurements the voltage of the case with respect to the anode or cathode is unimportant provided that it remains stable during the measurement of the impedance. In the cells measured so far, the voltages of the cell cases with respect to the individual electrodes differ from cell to cell even at the same overall cell voltage, but they remains stable with time. The measurements can thus be used to separate the cell impedance into the contributions of each electrode, allowing improved diagnosis of cell problems.

40861 (N–90-20454, pp. 279-295) **Nickel-hydrogen capacity loss on storage.** Manzo, M.A. National Aeronautics and Space Administration, Cleveland, OH (USA). Lewis Research Center. Dec 1989. (NASA-CP–3056;E–4708;NAS–1.55:3056;CONF-8904196–: 2. space electrochemical research and technology conference, Cleveland, OH (USA), 11-13 Apr 1989). In *Space electrochemical research and technology (SERT), 1989.* Available from NTIS, PC A16/MF A02.

A controlled experiment evaluating the capacity loss experienced by nickel electrodes stored under various conditions of temperature, hydrogen pressure, and electrolyte concentration was conducted using nickel electrodes from four different manufacturers. It was found that capacity loss varied with respect to hydrogen pressure, and storage temperature as well as with respect to electrode manufacturing processes. Impedance characteristics were monitored and found to be indicative of electrode manufacturing processes and capacity loss. Cell testing to evaluate state-of-charge effects on capacity loss were inconclusive as no loss was sustained by the cells tested in this experiment.

40862 (N–90-21116) **Effect of KOH concentration on LEO cycle life of IPV nickel-hydrogen flight battery cells.** Smithrick, J.J.; Hall, S.W. National Aeronautics and Space Administration, Cleveland, OH (USA). Lewis Research Center. 1990. 8p. (NASA-TM–103127;E–5457;NAS–1.15:103127;CONF-900801–: 25. intersociety energy conversion engineering conference, Reno, NV (USA), 12-17 Aug 1990). Available from NTIS, PC A02/MF A01.

A breakthrough in low earth orbit (LEO) cycle life of individual pressure vessel (IPV) nickel hydrogen battery cells was reported. The cycle life of boiler plate cells containing 26 percent potassium hydroxide (KOH) electrolyte was about 40,000 LEO cycles compared to 3500 cycles for cells containing 31 percent KOH. The effect of KOH concentration on cycle life was studied. The cycle regime was a stressful accelerated LEO, which consisted of a 27.5 min charge followed by a 17.5 min charge (2 x normal rate). The depth of discharge (DOD) was 80 percent. The cell temperature was maintained at 23 C. The next step is to validate these results using flight hardware and a real time LEO test. NASA Lewis has a

contract with the Naval Weapons Support Center (NWSC), Crane, Indiana, to validate the boiler plate test results. Six 48 A-hr Hughes recirculation design IPV nickel-hydrogen flight battery cells are being evaluated. Three of the cells contain 26 percent KOH (test cells) and three contain 31 percent KOH (control cells). They are undergoing real time LEO cycle life testing. The cycle regime is a 90-min LEO orbit consisting of a 54-min charge followed by a 36-min discharge. The depth-of-discharge is 80 percent. The cell temperature is maintained at 10 C. The cells were cycled for over 8000 cycles in the continuing test. There were no failures for the cells containing 26 percent KOH. There was two failures, however, for the cells containing 31 percent KOH.

40863 (PB–90-870643/XAB) **Lithium batteries. April 1974-April 1990 (A Bibliography from the US Patent data base). Report for April 1974-April 1990.** National Technical Information Service, Springfield, VA (USA). Jun 1990. 54p. Available from NTISPC N01/MF N01.

Supersedes PB–88-870597.

This bibliography contains citations of selected patents concerning lithium batteries and cells, and their application as power sources in electronic and electric devices. Electrode, electrolyte, and sealing materials used in the manufacture of lithium batteries are discussed. Additives used for stabilization, and safety control methods are also considered. (This updated bibliography contains 118 citations, 18 of which are new entries to the previous edition.)

40864 (PB–90-872037/XAB) **Nickel hydrogen batteries: Energy storage and applications. September 1979-May 1990 (A Bibliography from the International Aerospace Abstracts data base). Report for September 1979-May 1990.** National Technical Information Service, Springfield, VA (USA). Jun 1990. 79p. Available from NTISPC N01/MF N01.

U.S. sales only.

This bibliography contains citations concerning design and testing of nickel hydrogen battery systems to achieve high energy density and insensitivity to overcharge, charge reversal, and temperature extremes. These factors allow nickel hydrogen batteries to be used in adverse environments or under adverse discharge cycles, such as in spacecraft, aircraft, and electric vehicles. The citations reference development and testing of the electrodes, performance testing of the batteries in laboratories and spacecraft, and system designs for specific space applications. (Contains 165 citations fully indexed and including a title list.)

40865 (SAND–89-1748) **Thermal battery statistics and plotting programs.** Scharrer, G.L. Sandia National Labs., Albuquerque, NM (USA). Apr 1990. 51p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC04-76DP00789. Order Number DE90013873. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Thermal battery functional test data are stored in an HP3000 minicomputer operated by the Power Sources Department. A program was written to read data from a battery data base, compute simple statistics (mean, minimum, maximum, standard deviation, and K-factor), print out the results, and store the data in a file for subsequent plotting. A separate program was written to plot the data. The programs were written in the Pascal programming language. 1 tab.

40866 (SAND–90-1829C) **Development of the sodium/sulfur technology for energy storage.** Landgrebe, A. (USDOE Assistant Secretary for Conservation and Renewable Energy, Washington, DC (USA). Office of Energy Management); Magnani, N.J. Sandia National Labs., Albuquerque, NM (USA). [1990]. 6p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC04-76DP00789. (CONF-9006243–1: 8. beta battery workshop, Chester (UK), 12-18 Jun 1990). Order Number DE90014329. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The US Department of Energy (DOE) has supported the development of the sodium-sulfur technology since 1973. The programs have focused on progressing core aspects of the technology and completing initial battery engineering for both mobile and stationary applications. An overview of the Office of Energy Management (OEM) activities is contained in this paper. Two major development programs have been active: the first with Ford Aerospace and Communications Corporation (1975 to 1985), and the second with Chloride Silent Power Limited (1985 to 1990). With the completion this year of the qualification of a cell suitable for initial Solar Energy Systems (SES) applications, the emphasis of future DOE/OEM sodium/sulfur programs will shift to SES-battery engineering and development. The initial effort will resolve a number of issues related to the feasibility of utilizing the sodium/sulfur technology in these large-scale applications. This multi-year activity will represent the initial phase of an integrated long-term DOE-supported program to produce a commercially viable battery system.

29 ENERGY PLANNING AND POLICY

2901 Energy Analysis and Modeling

Refer also to citation(s) 40913

2902 Economics and Sociology

Refer also to citation(s) 40406, 40925

2903 Environment, Health, and Safety

Refer also to citation(s) 40599, 40687, 40890, 40936, 41521, 41537, 41539, 41554, 41555, 41556, 41557, 41563, 41565, 41614, 41634, 41653, 41738, 41740

40867 (AD-A–220854/4/XAB) **Environmental enforcement of federal agencies: A struggle for power under the New Federalism. Master's thesis.** Surver, R.E. Air Force Inst. of Tech., Wright-Patterson AFB, OH (USA). 1990. 113p. (AFIT/CI/CIA–90-007). Available from NTIS, PC A06/MF A01.

The challenge to Federalism presented by the new wave of environmental statutes is, while not unique in our history, a significant strain on state and federal relations. Behind this tension is the question of who should enforce these laws, especially when the violator is a Federal agency. Traditionally Federal agencies have been free to perform their diverse missions without restraint either from other Federal agencies or the states. This freedom has led to abuse in the arena of environmental compliance. Recent congressional hearings concerning amendments to the Resource Conservation and Recovery Act saw a congressional feeding frenzy over what was termed the abominable mess of federal facility environmental compliance. The obvious anger and frustration directed toward federal agencies, including the Environmental Protection Agency (EPA), by representatives of the states is a clear indicator of the extent of the problem and also a catalyst for an ill-conceived and dangerous legislative fix.

40868 (CONF-900556–1) **Remedial action decision process.** Travis, C.C.; Doty, C.B. Oak Ridge National Lab., TN (USA). [1990]. 15p. Sponsored by U.S. DOE Energy Research; Environmental Protection Agency. DOE Contract AC05-84OR21400. From Hazardous waste site investigations: toward better decisions; Gatlinburg, TN (USA); 21-24 May 1990. Order Number DE90014209. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The Superfund Amendments and Reauthorization Act of 1986 (SARA) provided the Environmental Protection Agency (EPA) with resources and direction for the identification, evaluation, and remediation of hazardous waste sites in the United States. In an attempt to obtain an overview of the Superfund remedial action decision process, we performed an in-depth analysis of 50 of the 74 Records of Decision (RODs) signed during fiscal year 1987. The objectives of the study were to characterize the role of risk assessment in the decision-making process and to determine whether SARA is being implemented in an effective and environmentally protective manner. The issues raised by our analysis of Records of Decision (RODs) and subsequent remedial actions center on the two fundamental elements of the decision-making process: setting priorities for deciding which sites to remediate and selecting cost-effective remedial alternative that provide for effective and permanent cleanup. 14 refs., 3 figs.

40869 (CONF-9007118–1) **The relevance of risk assessment to public health aspects of the national energy policy.** Barnthouse, L.W. Oak Ridge National Lab., TN (USA). 6 Jul 1990. 6p. Sponsored by U.S. DOE Environment Health & Safety. DOE Contract AC05-84OR21400. From Hearing on the national energy strategy, energy and public health; Bethesda, MD (USA); 6 Jul 1990. Order Number DE90013390. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

This paper is a transcript of an oral presentation by Lawrence W. Barnthouse of ORNL at the Hearing on National Energy Strategy at Bethesda, MD. The topics discussed are risk assessments of environmental conditions on public health; effects of radiation dose-rates on animals and man; and the need for a national environmental policy. (FSD)

40870 (DOE/EH–0135) **Performance objectives and criteria for technical safety appraisals at Department of Energy facilities and sites.** USDOE Assistant Secretary for Environment, Safety and Health, Washington, DC (USA). Jun 1990. 236p. Sponsored by U.S. DOE Environment Health & Safety. Order Number DE90013606. Available from NTIS, PC A11/MF A01 - OSTI; GPO Dep.

This document contains Performance Objectives and Criteria intended to serve as a working reference for the Department of Energy's Office of the Deputy Assistant Secretary for Safety and Quality Assurance in its Technical Safety Appraisals of the Department's more significant facilities and sites. The Performance Objectives are broad in scope. Each generally covers a single, well-defined management area. The supporting Criteria are more specific in scope and typically describe a particular activity that are listed under each Performance Objective. These criteria address requirements of a DOE Order, appropriate nuclear industry lessons-learned, appropriate NRC-licensed facility requirement, or appropriate industry standard.

40871 (PB–90-210998/XAB) **Model RCRA Permit for hazardous-waste-management facilities (draft).** Environmental Protection Agency, Washington, DC (USA). Office of Solid Waste. Sep 1988. 242p. (EPA–530/SW-90/049). Available from NTIS, PC A11/MF A02.

The primary purpose of the Model Permit is to assist permit writers in drafting or reviewing hazardous waste facility permits. The guidance document covers process-specific conditions for container storage areas, tanks, incinerators, waste piles, surface impoundments, land treatment areas, and landfills, etc. The introduction to the Model Permit discusses an approach with examples to developing permits.

40872 (PB–90-211004/XAB) **RCRA Permit quality protocol (draft).** Environmental Protection Agency, Washington, DC (USA). Office of Solid Waste and Emergency Response. Sep 1988. 232p. (EPA–530/SW-90/050). Available from NTIS, PC A11/MF A02.

The primary purpose of the Permit Protocol is to assist permit writers in drafting or reviewing hazardous waste facility permits. The Protocol is to be used in conjunction with the model permit to evaluate the technical completeness and adequacy of permits. The Protocol provides a checklist of permit conditions, which mirrors the model permit conditions for use in evaluating the completeness of the permit, and for a select number of permit conditions, the Protocol provides technical and enforceability evaluation criteria and guidance. In addition, the Protocol is to be used to help evaluate the completeness and adequacy of the administrative record in supporting permit conditions. The Protocol is used by headquarters when conducting regional reviews, and regions should use it when evaluating the states.

40873 (PB–90-212093/XAB) **Effect of emission constraint on the structure of energy systems.** Electrotechnical Lab., Tsukuba, Ibaraki (Japan). ©1989. 105p. (ETL-TR–89-5). Available from NTIS, PC A06/MF A01.

Text in Japanese; summary in English. Portions of this document are not fully legible.

The report describes the results of energy systems analysis carried out for the energy technology evaluation taking into account the emission of SOx, NOx, and CO2. The first part of the report briefs on the method of the analysis, the system model structure, and on the basic assumptions. The main results of the analysis obtained are: the long-term projection of energy consumption, the quantity of pollutant emission, the total system cost, and the sensitivity of the energy system structure and the technology implementation to the emission constraints. From those results, the cost-emission trade-off curves are derived and discussed.

40874 (PB–90-214354/XAB) **Superfund emergency response actions: A summary of federally funded removals. Volume 3.** Environmental Protection Agency, Washington, DC (USA). Office of Solid Waste and Emergency Response. Jun 1989. 125p. (EPA–540/8-89/005). Available from NTIS, PC A06/MF A01.

See also PB–90-197310.

Volume III summarizes short-term removal activities completed during the eighth year of the Superfund program. The document is presented as a series of matrices that are organized numerically by Region and alphabetically by State and site name within each Region. It contains the same types of information included in Volume I and II. EPA intends to continue providing the information in future updates. Inquiries regarding information contained in the document should be referred to the appropriate EPA Regional office. A list of EPA contacts and a map delineating the States within each Region are provided in the report. In addition, the document includes a listing of sites found in Volumes I and II. These sites are listed alphabetically by State within their respective Regions. In the back of the report, there is also an alphabetical index of all sites in Volumes I, II, and III.

40875 (PB–90-216516/XAB) **Superfund innovative technology evaluation program: Progress and accomplishments, Fiscal Year 1989. A third report to Congress.** Environmental Protection Agency, Washington, DC (USA). Office of Solid Waste and Emergency Response. Mar 1990. 83p. (EPA–540/5-90/001). Available from NTIS, PC A05/MF A01.

See also PB–89-215214.

This is the third Report to Congress on the Superfund Innovative Technology Evaluation (SITE) Program. The report summarizes the progress, accomplishments, and results of the SITE Program through 1989. Field demonstrations for eight projects have been completed since publication of the first report. The second Report to Congress focuses on the completed demonstrations and provides performance data and results. The process used to assess the economic feasibility of each demonstration is presented. The report describes the progress of the components that were initiated during the first year of the program and the two components implemented during the past year. Another difference between the two reports is that the second Report to Congress identifies the impediments encountered during the first 3 years of the program and describes the refinements that EPA has implemented to address these problems and improve the effectiveness of the SITE Program.

2905 Research, Development, Demonstration, and Commercialization

Refer also to citation(s) 40464, 40605, 40887, 42254

40876 (CONF-9006221–2) **Coping with export control and government regulations on technology transfer: A federal laboratory perspective.** Betten, P. Argonne National Lab., IL (USA). [1990]. 7p. Sponsored by U.S. DOE Energy Research. DOE Contract W-31109-ENG-38. From Annual technology transfer society meeting; Dayton, OH (USA); 28 Jun 1990. Order Number DE90013659. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

This paper discusses, from a federal laboratory perspective, the technology transfer problems of identifying and developing a program for controlling the flow of both technical data and hardware. Information and hardware flow at Argonne National Laboratory is discussed. The established program should be in compliance and in-tune with government and export control regulations. Effort is placed on educating the staff, such that the researcher retains freedom to publish, yet the staff is aware restrictions placed on certain types of information and technical data. 3 tabs.

2906 Nuclear Energy

Refer also to citation(s) 40672, 40675, 40687

40877 (AD-A–220301/6/XAB) **Recent trends and future prospects of terrorism in the United States.** Hoffman, B. Rand Corp., Santa Monica, CA (USA). May 1988. 78p. (RAND/R–3618). Available from NTIS, PC A05/MF A01.

This report examines recent trends and future prospects of terrorism in the United States and assesses their implications for the possibility of a terrorist group attempting an act of nuclear terrorism involving either the theft of a weapons system or strategic nuclear material or an attack on a weapons facility. An emerging trend of ideologically motivated terrorism by groups espousing white supremacist and anti-federalist beliefs or opposing specific issues such as abortion has largely supplanted the ethnic centered violence that dominated earlier domestic terrorist activity. The threat to U.S. nuclear weapons facilities from unknown terrorist groups in this country cannot be considered high at this time. There is no evidence to suggest that any of the organizations reviewed in this study have seriously contemplated a nuclear-related act, nor is there any indication that any group is poised to undertake such an attack in the future. Nevertheless, trends in the terrorist activities of certain groups must be considered in the context of possible operations directed against nuclear weapons sites. Members of these groups are considerably more skilled with weapons than are other terrorist in this country, they possess large stockpiles of sophisticated weapons, they are well trained guerrilla warfare and survival techniques, and they possess an apocalyptic vision of the future-factors that make them the most likely domestic terrorists to attempt an act of nuclear terrorism. In sum, while the volume of annual terrorist incidents in the United States is relatively small, the emerging trends merit intensive and continuing attention.

40878 (AD-A–220305/7/XAB) **Threat of nuclear terrorism: A re-examination.** deLeon, P.; Hoffman, B.; Kelien, K.; Jenkins, B. Rand Corp., Santa Monica, CA (USA). Jan 1988. 23p. (RAND/N–2706). Available from NTIS, PC A03/MF A01.

This Note reports the final results of the first phase of a two part study, the purpose of which is to describe the spectrum of capabilities of individuals and groups that could be considered likely to attempt the takeover or theft and misuse of a nuclear weapon over the next 10-15 years. This Note first analyzes the motivations that might inspire various acts of nuclear terrorism. Second, it reviews the altered contexts that might affect terrorists' decisions to go nuclear.

40879 (BMU–1989-221) **Radioactivity environmental monitoring abroad, activities and schemes.** Schriftenreihe Reaktorsicherheit und Strahlenschutz. Ergebnisberichte, Untersuchungen, Studien, Gutachten. Bundesministerium fuer Umwelt-, Naturschutz und Reaktorsicherheit, Bonn (Germany, F.R.); Technischer Ueberwachungs-Verein Rheinland e.V., Koeln (Germany, F.R.). Dec 1987. 77p. (In German). Contract BMU St.Sch. 1023. Available from GRM Werbeberatung - Werbemittlung - PR, Eggenstein-Leopoldshafen, (Germany, F.R.).

After the reactor accident in Chernobyl, an integrated measuring and information system on the basis of the Preventive Radiation Protection Act is to be established in the Federal Republic of Germany for the monitoring of the environmental radioactivity. For this purpose, information material from corresponding institutions in Belgium, France, Great Britain, the Netherlands, Austria, Switzerland, the European Community and IAEA is collected and evaluated. The REM data base in Ispra may be considered as a first step towards a joint European information system. (DG).

40880 Public communications: What works...what doesn't. Fiore, J. *Transactions of the American Nuclear Society (USA),* 59: 280 (1989). (CONF-890604–: Annual meeting of the American Nuclear Society, Atlanta, GA (USA), 4-8 Jun 1989).

The author offers advice concerning public relations efforts on the part of the nuclear industry. It is stated that what works is honesty, no patronizing and grassroots efforts toward educating the public regarding the benefits of nuclear power. What does not work is fighting fear with facts, coverups, underestimation of intervenor impacts, and doing nothing. It is not too late to change the public perception of the nuclear industry.

40881 Why public information works: Research findings on organizational and individual impact. Bisconti, A.S. *Transactions of the American Nuclear Society (USA),* 59: 280-281 (1989). (CONF-890604–: Annual meeting of the American Nuclear Society, Atlanta, GA (USA), 4-8 Jun 1989).

Broad and growing public recognition of the importance of nuclear energy in the United States is evident in the public opinion polls, continued defeat of antinuclear referenda, positive Congressional actions, and open support by politicians-from the National Conference of State Legislatures to President Bush. At leadership levels, the need to address the looming electricity crisis without increasing dependence on foreign oil or greenhouse gas emissions is being voiced increasingly. Within this context, the industry is beginning to be successful in getting its message across to the American public through national advertising and media and public relations programs of the U.S. Council for Energy Awareness (USCEA). And the author knows that the American Nuclear Society (ANS) Public Information Committee is working hard in complementary kinds of public education. Research shows that the public's attitudes toward nuclear energy become more favorable when they are exposed to public information and that a more active scientific community could greatly increase public recognition of the benefits that nuclear energy provides.

40882 High-flying public information maneuvers or it's all up in the air. McKlveen, J.W. *Transactions of the American Nuclear Society (USA),* 59: 281-282 (1989). (CONF-890604–: Annual meeting of the American Nuclear Society, Atlanta, GA (USA), 4-8 Jun 1989).

Two major public information programs have been developed by the Radiation Measurements Facility (RMF) at Arizona State University. One is associated with a nuclear power station and the other involves uranium mining in the Grand Canyon. Public information for both situations involved the usual speeches to schools and civic groups. However, a unique strategy was developed to accommodate the media. The laboratory has gained respect and a reputation for being caring, helpful, and honest-a place where one can go to get straight answers.

40883 Communicating facts through third-party partnerships. Kearns, K.D. *Transactions of the American Nuclear Society (USA),* 59: 283 (1989). (CONF-890604–: Annual meeting of the American Nuclear Society, Atlanta, GA (USA), 4-8 Jun 1989).

Every day in the United States people are making decisions about the future of nuclear energy, while it continues to be one of our most controversial issues. How these decisions turn out and whether they are based on fact and need or fear and misconceptions will depend in large part on how active a role knowledgeable people choose to play in the public arena. The participation of scientists and engineers, industry employees, and operators is particularly important because of the respect the public has for their knowledge of the issues. There are a number of very successful programs in which individuals participate through meaningful partnerships with larger national public information efforts. This paper reviews two such partnership programs and makes generalized conclusions about their success and their importance.

40884 Massachusetts nuclear power referendum: Lessons learned from the campaign trail. Allen, S.R. *Transactions of the American Nuclear Society (USA),* 59: 282-283 (1989). (CONF-890604–: Annual meeting of the American Nuclear Society, Atlanta, GA (USA), 4-8 Jun 1989).

Last November, Massachusetts voters cast their ballots on a binding initiative which, if passed, would have prohibited the production of high-level waste, thereby permanently shutting down the state's two nuclear power plants: Yankee and Pilgrim. Question 4, as the initiative became known, posed an unprecedented challenge for the state's six major utilities. Essentially, Question 4 was defeated for two reasons: compelling arguments and a well-founded strategy for communicating those arguments. One part of that strategy was the use of debates and public-speaking engagements before both civic groups and on radio/television. These debates

and presentations were clearly the most interesting part of the campaign and provided many insights that may be applied to long-term public policy and informational programs. Obviously, there is a significant difference between an intense, focused campaign and an ongoing, diverse public information program-but many of the principles are the same. The purpose of this paper is to review some of the key lessons learned from over 300 debates and presentations in the highly emotional atmosphere of the Question 4 campaign. Throughout the campaign, debaters and speakers submitted after action reports, and it is from these as well as the overall campaign results that the lessons and anecdotes are derived.

40885 Pretour in-servicing of teachers and students: Effects on tour program. Walker, R.J. *Transactions of the American Nuclear Society (USA),* 59: 283-284 (1989). (CONF-890604–: Annual meeting of the American Nuclear Society, Atlanta, GA (USA), 4-8 Jun 1989).

Plant tour programs constitute a major educational outreach program for nuclear facilities. As a result of observing exhibits, touring facilities, and interacting with plant personnel, students become more informed and receptive to the nuclear energy issue. With this new information, students have a better understanding of the plant, its operation, and its place in their future. The management of the Perry power plant in Perry, Ohio, has recognized the need for, and the benefits to be derived from, a plant tour program for students. These students are tomorrow's customers and voters. It has also recognized the problems inherent in providing such tours; for instance, a visit to a nuclear power plant can overwhelm unprepared students. Another problem is that resource materials regarding nuclear energy that are available to educators are often outdated. To address this lack of educational material and to improve the educational quality of the tour program, the Perry plant has developed a three-step program. This program includes a new energy education center and a walking tour of its unfinished unit 2 facility. Updated materials are delivered to the classroom familiarizing both teachers and students with the concepts and terminology that will be used during their visit. As a result of the familiarization, the students leave the tour experience with a greater understanding and awareness of the nuclear cycle. This serves to strengthen ties with area school districts, because the power plant is now looked upon as an educational resource.

2910 Conservation

Refer also to citation(s) 40892, 40915, 40937

40886 (DOE/BP/34673–1) **Energy efficient software directory for the industrial customer.** Engineering Information, Inc., New York, NY (USA). May 1990. 171p. Sponsored by U.S. DOE Bonneville Power Administration. DOE Contract AC79-87BP34673. Order Number DE90014154. Available from NTIS, PC A08/MF A01 - OSTI; GPO Dep.

The purpose of this Directory is to assist plant engineers and managers to determine how much energy they could save by using electricity more efficiently. It is also designed to encourage the open exchange of information on industrial energy software.

40887 (DOE/CE–0291P) **Eleventh annual report to Congress and the Secretary of Energy on the Nationwide Energy Extension Service Program.** National Energy Extension Service Advisory Board, Washington, DC (USA). Jul 1990. 12p. Sponsored by U.S. DOE Conservation & Renewable Energy. Order Number DE90013632. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This document is the eleventh annual report to Congress by the Energy Extension Service on progress in partnership with states to provide technical assistance to small energy users in energy conservation through education and technology transfer. (FSD)

40888 (PB–90-224619/XAB) **Energy-conservation-investment decision making in developing countries: A review of project implementation in industry. Final report.** RCG/Hagler, Bailly, Inc., Washington, DC (USA). Dec 1989. 153p. (HBI-REF–89-4222-171). Available from NTIS, PC A08/MF A01.

Despite recent efforts in a number of developing countries to promote energy conservation (EC) and efficiency, only a fraction of EC potential has been captured, especially for projects that require significant investments. The document analyzes EC efforts in 11 countries where energy audit and/or feasibility study programs have been carried out (Bangladesh, Costa Rica, Ecuador, El Salvador, Guatemala, Honduras, Jordan, Pakistan, Panama, the Philippines, and Sri Lanka), covering some 1,500 EC projects involving 242 industrial companies. Cost and length of payback seem to be the determining factors for companies considering EC measures; no-cost or low-cost projects with paybacks of less than a year (such as power factor improvement projects) had the highest rate of implementation, while expensive, complicated projects (e.g., cogeneration or fuel substitution projects) were most often rejected. The document concludes, however, that the rate of implementation of EC programs has been quite high, and recommends that inexpensive, short-term projects be featured in future EC programs and increased levels of TA and financial assistance be made available to companies implementing long-term EC measures.

2920 Supply, Demand, and Forecasting

Refer also to citation(s) 40891

2930 Policy, Legislation, and Regulation

Refer also to citation(s) 40361, 40687, 40876, 40893, 40919, 41537

2940 Fossil Fuels

Refer also to citation(s) 40328, 40338, 40349, 40357, 40360, 40361, 40599

2960 Electric Power

Refer also to citation(s) 40350, 40947

40889 (CONF-900628–2) **Technology choice in a least-cost expansion analysis framework: Implications for system reliability.** Guziel, K.A.; South, D.W. Argonne National Lab., IL (USA). [1990]. 11p. Sponsored by U.S. DOE Fossil Energy. DOE Contract W-31109-ENG-38. From 17. international conference for the electric power industry: reliability, availability, maintainability strategies for the 90's; Hershey, PA (USA); 12-15 Jun 1990. Order Number DE90013675. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

It is inevitable that new power plants will need to be constructed in the near future; however, it is unclear which technologies will be selected for these new plants. In a study for the US Department of Energy, the impact of fuel prices, length of the planning period, and the characteristics of the generating system were examined for their influence on technology choice in 10 representative power pools. It was determined that natural gas combined-cycle technology was generally preferred for base-load and intermediate/cycling capacity when gas prices are low and the planning period is short (10 years). Integrated coal gasification combined-cycle plants were selected to serve most base-load requirements under other conditions. One aspect often overlooked in making a least-cost technology choice can be made if alternative expansion plans do not have the same level of reliability when discounted system costs are compared. 5 refs., 2 figs., 17 tabs.

40890 (CONF-9005112–1) **But the replaced refrigerator was landfilled: A method for including environmental benefits and costs in least-cost utility planning (LCUP).** Bernard, M.J. III. Argonne National Lab., IL (USA). [1990]. 18p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract W-31109-ENG-38. From Innovations in pricing and planning; Milwaukee, WI (USA); 2-4 May 1990. Order Number DE90013684. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

We are entering a decade of enhanced environmental awareness. While considerable agreement exists that accounting for environmental externalities in least-cost utility planning is important, in actual practice environmental considerations are often given qualitative attention, at best. Given the political difficulty in deriving financial tests of demand-side projects, this is not surprising. Each step — from energy extraction, through one or more conversions,

transport and transmission, and to use — could impact the environment considerably. So might the extraction of materials for the production and the disposal of related hardware. To mitigate these effects state and federal legislation requires such actions as land reclamation, emission controls, and improved energy conversion efficiency. For example, think about the above title. The replaced refrigerator's foam insulation and freon contain CFCs. Its metal has value. But the evaluation of the utility's high-efficiency refrigerator rebate program did not account for the cost of disposing of the refrigerator in an environmentally sound manner, i.e., it missed some costs. Understanding environmental aspects of demand-side programs and the methods to include them in planning puts most practitioners of utility planning in an unfamiliar arena. This paper describes a process of including environmental planning and environmental costs and benefits in utility planning. It is based on the classical planning process and a method for making the trade-offs among environmental and other effects of utility programs is discussed. It then discusses the types of environmental impacts that can be expected from various types of demand- and supply-side utility programs and gives a detailed example of the environmental concerns associated with an electric utility's introduction of electric vehicles in an urban area. 8 refs., 5 figs.

40891 (IAEA-TECDOC–528, pp. 103-113) **Present development plans and future options of Indonesia's electric power systems.** Affif, A. (State Electric Power Corp. (PLN), Jakarta (Indonesia)); Tamin, H.S. International Atomic Energy Agency, Vienna (Austria). Oct 1989. (CONF-8812139–: RCA workshop on the WASP/MAED coomputer programs, Kuala Lumour (Malaysia), 5-9 Dec 1988). In *Experience with WASP and MAED among IAEA Member States participating in the Regional Co-operative Agreement (RCA) in Asia and the Pacific Region: Proceedings of the RCA workshop on the WASP/MAED computer programs held in Kuala Lumpur, Malaysia 5-9 December 1988.* Order Number DE90634346. Available from NTIS (US Sales Only), PC A13/MF A01; OSTI; INIS.

Indonesia is a country endowed with large amounts and diverse types of energy resources for potential use in electricity production. However, the archipelago characteristic of the country and the disparity between population concentration and that of the location of the energy resources makes difficult the exploitation of all these resources for electricity generation. This paper reviews the status of the electric power industry in Indonesia and the plans set up for coping with the rapid increase of electricity demand. Electricity supply in Indonesia has largely been dependent on oil. Present efforts at PLN are geared to lessen this reliance on oil and to shift to other primary resources such as coal, hydro, geothermal and natural gas. In the short term, large scale use of natural gas is envisaged for electric power generation with the installation of combined cycle plants. In the long term, steam coal-fired plants will play a major role in meeting future electric demand. Much effort is also being expended in devising a pricing policy which could be particularly effective in energy demand management. (author). 7 tabs.

40892 (LBL–28019) **Ratemaking for conservation: The California ERAM [Electric Rate Adjustment Mechanism] experience.** Marnay, C. (Lawrence Berkeley Lab., CA (USA)); Comnes, G.A. Lawrence Berkeley Lab., CA (USA). Mar 1990. 60p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC03-76SF00098. Order Number DE90013361. Available from NTIS, PC A04/MF A01 - OSTI; GPO Dep.

The Electric Rate Adjustment Mechanism (ERAM), adopted by the California Public Utilities Commission for the major investor-owned utilities in the state, represents a major departure from traditional rate-of-return ratemaking. ERAM removes the anti-conservation bypass of ratemaking by ensuring the utility will fully collect its authorized revenue requirement irrespective of the level of sales. Over or undercollections of revenues accrue to a balancing account and are amortized into future rates. This mechanism protects the utility from the risk of sales deviating from expectations for all reasons. Shielding the utility in this way can confound other policy goals which rely on the utility facing incentives other than those created by ERAM. 21 refs., 1 fig., 3 tabs.

40893 (PB–90-591200/XAB) **Electric Utilities Monthly Sales and Revenue Report (EIA-826), current. Data file.** National Energy Information Center, Washington, DC (USA). 1990. mag ta Available from NTISStanding Order.

Supersedes PB–89-181192. Source tape is in the EBCDIC character set. This restricts preparation to 9 track, one-half inch tape only. Identify recording mode by specifying density only. For price at 6250 bpi density, call NTIS Computer Products. Avail. on Standing Order, Deposit Account required. North American Continent price based on no. of updates; individual issue $220.00; all others write for quote. Issued monthly.

Form EI-826, formerly FERC-5, Electric Utility Company Monthly Statement, collects data necessary to fulfill regulatory responsibility; identify near-term trends in energy use; and contingency analysis. The form is filed monthly by approximately 150 electric utilities. All privately owned electric utilities with annual electric operating revenues of $100,000,000 or more must respond. In addition, the sample includes other selected electric utilities. The reported data is expanded by factors, calculated using annual data from a previous period, to give electric sales data by state and sector. Other information collected includes data gathered on depreciation, construction, net income before taxes, and extraordinary items.

40894 (PNL–7237) **Impact evaluation of an energy savings plan project at Bellingham Cold Storage.** Spanner, G.E.; Dixon, D.R.; Fishbaugher, M.J. Pacific Northwest Lab., Richland, WA (USA). Jun 1990. 21p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC06-76RL01830. Order Number DE90013373. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This impact evaluation of an energy conservation measure (ECM) that was recently installed at Bellingham Cold Storage (BCS) was conducted for the Bonneville Power Administration (Bonneville) as part of an evaluation of its Energy Savings Plan (ESP) Program. The Program awards cash incentives to firms that install energy conservation measures in their industrial processes. The objective of this impact evaluation was to assess how much electrical energy is being saved at BCS as a result of the ESP and to determine how much savings cost Bonneville and the region. The impact of the ECM was evaluated with a combination of engineering analysis, financial analysis, interviews, submittal reviews (BCS's Completion Report, Proposal, and Abstract), and process evaluation reviews. The ECM itself consists of an energy management and control system that is used to manage energy consumption by a large refrigeration system at BCS's Orchard Drive facility in Bellingham, Washington. At this facility, BCS freezes and stores fruits, berries, and fish products, while two tenants process frozen fish products. Energy savings resulting from this ECM are expected to be at least 1,094, 402 kWh during the first year (a savings of 23%) with greater savings in subsequent years. The ECM cost BCS $169,300 to install, Bonneville paid an incentive to BCS of $65,100, and the local utility paid an additional incentive of $21,700. The levelized cost of these savings to Bonneville will be no greater than 5.0 mills/kWh over the ECM's expected 15-year life, and the cost to the region will be no greater than 12.5 mills/kWh. It is expected that this ECM would have been installed within 3 years even without the incentive from Bonneville, and the levelized cost to Bonneville for just the first three years' savings is 21.03 mills/kWh or less. 3 tabs.

2990 Unconventional Sources and Power Generation

Refer also to citation(s) 40599

30 DIRECT ENERGY CONVERSION

3001 MHD Generators

Refer also to citation(s) 40588

40895 (CONF-900801–18) **The need for superconducting magnets for MHD seawater propulsion.** Doss, E.D.; Geyer, H.K.

Argonne National Lab., IL (USA). [1990]. 7p. Sponsored by U.S. Department of Defense. DOE Contract W-31109-ENG-38. Contract N00014-89-F-0064. From 25. intersociety energy conversion engineering conference; Reno, NV (USA); 12-17 Aug 1990. Order Number DE90013651. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

An MHD model that couples an one-dimensional flow model to a two- dimensional electrical model has been developed to demonstrate the need of high strength magnetic fields and to investigate the influence of friction and end losses on the performance of MHD thrusters. Parametric studies have been performed using the model that includes the variation of the applied magnetic field (5-20 T), thruster diameter (0.5-2.0 m), wall roughness (0-3 mm), flow velocity (5-20 m/s), and the load factor (1-10). The results indicate that friction and end losses can have a deleterious effect on the thruster efficiency close to a load factor equal to unity. Furthermore, the parameter studies show that the thruster efficiency increases with the strength of the magnetic field and thruster diameter and decreases with wall roughness and the flow velocity. Careful considerations should be given to the analysis and the design of MHD thrusters for load factors close to one. 9 refs.

40896 (CONF-9006105–9) **Effects of friction and end losses on MHD thruster efficiency.** Doss, E.D.; Geyer, H.K. Argonne National Lab., IL (USA). [1990]. 8p. Sponsored by U.S. Department of Defense. DOE Contract W-31109-ENG-38. Contract N00014-89-F-0064. From 28. symposium on engineering aspects of magnetohydrodynamics; Chicago, IL (USA); 26-28 Jun 1990. Order Number DE90013673. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

A parametric study has been performed to investigate the influence of friction and end losses on the performance of MHD thrusters. An MHD model that couples a one-dimensional flow model to a two-dimensional electrical model has been developed and used in the analysis. The parametric study includes the variation of the applied magnetic field (5–20 T), thruster diameter (0.5–2.0 m), wall roughness (0–3 mm), flow velocity (5–20 m/s), and the load factor (1–10). The results indicate that friction and end losses can have a deleterious effect on the thruster efficiency close to a load factor equal to unity. Furthermore, the parameter studies show that the thruster efficiency increases with the strength of the magnetic field and thruster diameter and decreases with the wall roughness and the flow velocity. Careful considerations should be given to the analysis and the design of MHD thrusters for load factors close to one. 9 refs., 8 figs.

3005 Fuel Cells

Refer also to citation(s) 41039

40897 (CONF-9005195–2) **Molten carbonate fuel cell research.** Smith, J.L.; Brown, A.P.; Kucera, G.H. Argonne National Lab., IL (USA). [1990]. 10p. Sponsored by U.S. DOE Fossil Energy. DOE Contract W-31109-ENG-38. From METC contractors review meeting; Morgantown, WV (USA); 2-3 May 1990. Order Number DE90013896. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The emphasis of this project is to develop new electronically conductive ceramic materials that are chemically and polymorphically stable in molten carbonate fuel cell (MCFC) environments and to test these materials as MCFC components (i.e., electrodes and separator sheets). this quarter, the electric conductivity of undoped and niobium-doped $LiFeO_2$ and undoped MnO was measured. Also, methods to increase the surface area of the cathodes is discussed. 4 refs., 3 figs.

40898 (CRIE-W–89012) **10kW class molten carbonate fuel cell test.: Stack with electrolyte plate prepared with paper-making method(Part 1).** Izaki, Y.; Watanabe, T.; Mugikura, Y.; Hayasaka, T.; Shimazu, K.; Hamamatsu, T.; Abe, T.; Ishikawa, H.; Kusunose, N.; Shundo, Y. Central Research Inst. of Electric Power Industry, Tokyo (Japan). Oct 1989. 31p. (In Japanese). Order Number DE90507841. Available from NTIS (US Sales Only), PC A03/MF A01.

In Central Research Institute of Electric Power Industry (CRIEPI) , 10kW class Molten Carbonate Fuel Cell (MCFC) Test Facility has been installed at Yokosuka Laboratory, and operation experiments have been performed. This paper describes about the experimental results. An operation experiment of about 250 hours was carried out, using large MCFC stack with the Electrolyte Plate prepared with Paper Making Method made by Fuji Electric Co. Ltd. The test stack was designed by adopting internal manifold and co-flow type as gas flow structure. It was clarified that high fuel utilization operation is very important, because the energy conversion efficiency depends very hardly on fuel utilization ratio. Output power of the stack depends on the partial pressure of Oxygen in cathode oxidizing agent gas, but the amount of dependency is not clear. It was recognized that the temperature control for keeping operation without any outside heater is possible, as the amount of producing heat by power generation becomes more than heat loss and gas removal heat at the electric current over 200A (2/3 load) . 17 figs., 4 tabs.

40899 (CRIE-W–89022) **Performance of bench-scale MCFC with electrolyte plate made by paper-making method.** Mugikura, Y.; Watanabe, T.; Izaki, Y.; Hamamatsu, T.; Abe, T.; Ishikawa, H.; Kusunose, N.; Syundo, Y.; Maruyama, S.; Koseki, K. Central Research Inst. of Electric Power Industry, Tokyo (Japan). Dec 1989. 50p. (In Japanese). Order Number DE90507884. Available from NTIS (US Sales Only), PC A03/MF A01.

This paper studied ther fundamental characteristics of a bench-scale MCFC with electrolyte plates made by paper-making method. The performane depends greatly on temperature and is 2.8mV/centigrade, because the internal resistance and reaction resistace decrease with the increase of temperature. Anodic reaction depends hardly on temperature but cathodic rection depends greatly on temperature. The performance increase due to elevating pressure became slowdown with the increase of pressure. This result agreed with that made for 250cm ^{2} fuel cell. Parametric design equations between temperature, pressure and gas composition were prepared with obtained data, but the coefficients are different to those of equations Prepared by ITG (Institute of Gas Technology). As to the performance change on standing, voltage decreasing rate at 600 centigrade operation is smaller than that at 650 centigrade operation, and the effect of cathodic humidification was not found after 2,000 hours operation. For the performance change on standing in case of 3 atmosphere, voltage decreasing rate was 10 times larger than those for other conditions. 19 refs., 39 figs., 8 tabs.

40900 (ECN-C–90-004) **The development of new cathode materials for the use in molten carbonate fuel cells: Dutch MCFC development programme. Final report May 1986 to December.** Sitters, E.F.; Veldhuis, J.B.J.; Plomp, L.; Cordfunke, E.H.P. Netherlands Energy Research Foundation, Petten (Netherlands). Jan 1990. 55p. Contract CEC EN3E0152 NL;Contract NOVEM 19.610-0031. Order Number DE90797092. Available from NTIS (US Sales Only), PC A04/MF A01.

After a short introduction on the materials problems with the state-of-the-art nickel oxide cathode, the requirements for alternative MCFC (molten carbonate fuel cell) cathode materials, the research strategy and selected materials, results of the research and development on the title subject are presented. First the characterization methods used, i.e. standard techniques for materials characterization and methods especially developed for the measurements of electrical properties are dealt with. The results of a study considering the applicability of cyclic voltametry to the dissolution of cathode materials are given. Then the preparation techniques, developed to obtain samples for materials research, as well as techniques for the fabrication of powders with well defined particle characteristics, are described. Subsequently attention is paid to the actual materials development, which has been concentrated mainly on lithium ferrite. It is concluded that $LiFeO_2$ is a promising candidate for the replacement of NiO cathode in MCFC. Recommendations are given for future research on lithium ferrite, but also on other materials ($LiCoO_2$, $NiFe_2O_4$, $CoFe_2O_4$). 36 figs., 50 refs., 4 tabs.

40901 (ECN-C–90-005) **Development of alternative anode materials for molten carbonate fuel cells: Dutch MCFC Development Programme. Final report May 1986 to December.** Sitters, E.F.; Veldhuis, J.B.J.; Plomp, L.; Cordfunke, E.H.P. Netherlands Energy Research Foundation, Petten (Netherlands). Jan 1990. 40p. Contract NOVEM 19.61-040;Contract NOVEM 19.610-0042. Order Number DE90797093. Available from NTIS (US Sales Only), PC A03/MF A01.

After a short introduction on the materials problems with the state-of-the-art nickel anode, the requirements for alternate MCFC (molten carbonate fuel cell) cathode materials, the research strategy and selected materials, results of the R and D program on the title subject are presented. First the characterization methods used, i.e. standard techniques for materials characterization and methods especially developed for the measurements of electrical properties are dealt with. Then the preparation techniques that have been developed to obtain samples for materials research as well as techniques for the fabrication of powders with well defined particle characteristics are described. Subsequently attention is paid to the actual materials development, which has been concentrated mainly on lithium titanate and lithium vanadate. It is concluded that both tithium meta titanate (Li_2TiO_3) and lithium vanadate ($LiVO_2$) are promising candidates for the replacement of the state-of-the-art nickel anode. Recommendations are given for future research on these materials with regard to solubility under MCFC conditions, porous structures, morphological stability and dopants for Li_2TiO_3. 16 figs., 5 tabs., 36 refs.

40902 (ECN-RX–90-027) **NIO cathode dissolution and long term MCFC operation.** Veldhuis, J.B.J.; Van der Molen, S.B.; Makkus, R.C.; Broers, G.H.J. Netherlands Energy Research Foundation, Petten (Netherlands). Apr 1990. 32p. Order Number DE90797107. Available from NTIS (US Sales Only), PC A03/MF A01.

Submitted for publication in: Berichte der Bunsengesellschaft fuer Physikalische Chemie (F.R. Germany). ISSN 0005-9021. BBPCA.

The lifetime of a molten carbonate fuel cell is significantly reduced by the slow dissolution of the state-of-the-art nickel oxide cathode material. The dissolved Ni ions precipitate in the matrix. The amount of nickel found in the matrix and the location of the precipitation zone observed in small size cell tests are reported. These cells were operated for various times, up to 20,000 hours. An average dissolution rate of 4 microgramme/cm^2h was calculated. The precipitation zone moved linearly with the square root of time towards the anode. This may be due to changes in the matrix and electrode structure and, additionally, to the surface diffusion of the precipitated metallic nickel. The results obtained are compared with a simple model describing the transport of nickel through the matrix and the location of the precipitation band. This model accounts for the diffusion, migration and the coupling of the dissolved species to the movement of the carbonate ions. The model calculations agree reasonably well with the experimental results. 9 figs., 9 refs., 7 tabs.

40903 (N–90-20454, pp. 41-49) **Monolithic solid oxide fuel cell development.** Myles, K.M.; Mcpheeters, C.C. National Aeronautics and Space Administration, Cleveland, OH (USA). Lewis Research Center. Dec 1989. (NASA-CP–3056;E–4708;NAS–1.55:3056;CONF-8904196–: 2. space electrochemical research and technology conference, Cleveland, OH (USA), 11-13 Apr 1989). In *Space electrochemical research and technology (SERT), 1989.* Available from NTIS, PC A16/MF A02.

The feasibility of the monolithic solid oxide fuel cell (MSOFC) concept has been proven, and the performance has been dramatically improved. The differences in thermal expansion coefficients and firing shrinkages among the fuel cell materials have been minimized, thus allowing successful fabrication of the MSOFC with few defects. The MSOFC shows excellent promise for development into a practical power source for many applications from stationary power, to automobile propulsion, to space pulsed power.

40904 (N–90-20454, pp. 95-113) **Recent advances in solid polymer electrolyte fuel cell technology with low platinum loading electrodes.** Srinivasan, S. (Ruhr Univ., Bochum (Germany, F.R.)); Manko, D.J.; Koch, H.; Enayetullah, M.A.; Appleby, A.J. National Aeronautics and Space Administration, Cleveland, OH (USA). Lewis Research Center. Dec 1989. (NASA-CP–3056;E–4708;NAS–1.55:3056;CONF-8904196–: 2. space electrochemical research and technology conference, Cleveland, OH (USA), 11-13 Apr 1989). In *Space electrochemical research and technology (SERT), 1989.* Available from NTIS, PC A16/MF A02.

Of all the fuel cell systems only alkaline and solid polymer electrolyte fuel cells are capable of achieving high power densities (greater than 1 W/sq cm) required for terrestrial and extraterrestrial applications. Electrode kinetic criteria for attaining such high power densities are discussed. Attainment of high power densities in solid polymer electrolyte fuel cells has been demonstrated earlier by different groups using high platinum loading electrodes (4 mg/sq cm). Recent works at Los Alamos National Laboratory and at Texas A and M University (TAMU) demonstrated similar performance for solid polymer electrolyte fuel cells with ten times lower platinum loading (0.45 mg/sq cm) in the electrodes. Some of the results obtained are discussed in terms of the effects of type and thickness of membrane and of the methods platinum localization in the electrodes on the performance of a single cell.

40905 (N–90-20454, pp. 11) **The application of Dow Chemical's perfluorinated membranes in proton-exchange membrane fuel cells.** Eisman, G.A. National Aeronautics and Space Administration, Cleveland, OH (USA). Lewis Research Center. Dec 1989. (NASA-CP–3056;E–4708;NAS–1.55:3056;CONF-8904196–: 2. space electrochemical research and technology conference, Cleveland, OH (USA), 11-13 Apr 1989). In *Space electrochemical research and technology (SERT), 1989.* Available from NTIS, PC A16/MF A02.

Dow Chemical's research activities in fuel cells revolve around the development of perfluorosulfonic acid membranes useful as the proton transport medium and separator. Some of the performance characteristics which are typical for such membranes are outlined. The results of tests utilizing a new experimental membrane useful in proton-exchange membrane fuel cells are presented. The high voltage at low current densities can lead to higher system efficiencies while, at the same time, not sacrificing other critical properties pertinent to membrane fuel cell operation. A series of tests to determine response times indicated that on-off cycles are on the order of 80 milliseconds to reach 90 percent of full power. The IR free voltage at 100 amps/sq ft was determined and the results indicating a membrane/electrode package resistance to be .15 ohm-sq cm at 100 amps/sq ft.

40906 (N–90-20454, pp. 11) **Electrocatalysis for oxygen electrodes in fuel cells and water electrolyzers for space applications.** Prakash, J.; Tryk, D.; Yeager, E. National Aeronautics and Space Administration, Cleveland, OH (USA). Lewis Research Center. Dec 1989. (NASA-CP–3056;E–4708;NAS–1.55:3056;CONF-8904196–: 2. space electrochemical research and technology conference, Cleveland, OH (USA), 11-13 Apr 1989). In *Space electrochemical research and technology (SERT), 1989.* Available from NTIS, PC A16/MF A02.

In most instances separate electrocatalysts are needed to promote the reduction of O_2 in the fuel cell mode and to generate O_2 in the energy storage-water electrolysis mode in aqueous electrochemical systems operating at low and moderate temperatures (T greater than or equal to 200 C). Interesting exceptions are the lead and bismuth ruthenate pyrochlores in alkaline electrolytes. These catalysts on high area carbon supports have high catalytic activity for both O_2 reduction and generation. Rotating ring-disk electrode measurements provide evidence that the O_2 reduction proceeds by a parallel four-electron pathway. The ruthenates can also be used as self-supported catalysts to avoid the problems associated with carbon oxidation, but the electrode performance so far achieved in the research at Case Western Reserve University (CWRU) is considerably less. At the potentials involved in the anodic mode the ruthenate pyrochlores have substantial equilibrium solubility in concentrated alkaline electrolyte. This results in the loss of catalyst into the bulk solution and a decline in catalytic activity. Furthermore, the hydrogen generation counter electrode may become contaminated with reduction products from the pyrochlores (lead, ruthenium).

40907 (N–90-20454, pp. 15) **Oxygen electrodes for rechargeable alkaline fuel cells-II.** Swette, L.; Kackley, N. National Aeronautics and Space Administration, Cleveland, OH

(USA). Lewis Research Center. Dec 1989. (NASA-CP–3056;E–4708;NAS–1.55:3056;CONF-8904196–: 2. space electrochemical research and technology conference, Cleveland, OH (USA), 11-13 Apr 1989). In *Space electrochemical research and technology (SERT), 1989.* Available from NTIS, PC A16/MF A02.

The primary objective of this program is the investigation and development of electrocatalysts and supports for the positive electrode of moderate temperature single-unit rechargeable alkaline fuel cells. Approximately six support materials and five catalyst materials have been identified to date for further development.

40908 (N–90-20454, pp. 6) **Non-noble electrocatalysts for alkaline fuel cells.** Sarangapani, S.; Lessner, P.; Manoukian, M.; Giner, J. National Aeronautics and Space Administration, Cleveland, OH (USA). Lewis Research Center. Dec 1989. (NASA-CP–3056;E–4708;NAS–1.55:3056;CONF-8904196–: 2. space electrochemical research and technology conference, Cleveland, OH (USA), 11-13 Apr 1989). In *Space electrochemical research and technology (SERT), 1989.* Available from NTIS, PC A16/MF A02.

The doping of solid phase precursors followed by pyrolysis or the copyrolysis of gas phase precursors has allowed us to produce catalysts with good activity toward oxygen reduction. Efforts are currently underway to better understand the reasons for the catalytic activity of the bulk doped catalysts with a view toward further improving their activity.

40909 (N–90-20454, pp. 127-136) **Hydrogen-oxygen proton-exchange membrane fuel cells and electrolyzers.** Baldwin, R. (Hamilton Standard, Windsor Locks, CT (USA)); Pham, M.; Leonida, A.; McElroy, J.; Nalette, T. National Aeronautics and Space Administration, Cleveland, OH (USA). Lewis Research Center. Dec 1989. (NASA-CP–3056;E–4708;NAS–1.55:3056;CONF-8904196–: 2. space electrochemical research and technology conference, Cleveland, OH (USA), 11-13 Apr 1989). In *Space electrochemical research and technology (SERT), 1989.* Available from NTIS, PC A16/MF A02.

Hydrogen-oxygen solid polymer electrolyte (SPE) fuel cells and SPE electrolyzers (products of Hamilton Standard) both use a Proton-Exchange Membrane (PEM) as the sole electrolyte. These solid electrolyte devices have been under continuous development for over 30 years. This experience has resulted in a demonstrated ten-year SPE cell life capability under load conditions. Ultimate life of PEM fuel cells and electrolyzers is primarily related to the chemical stability of the membrane. For perfluorocarbon proton exchange membranes an accurate measure of the membrane stability is the fluoride loss rate. Millions of cell hours have contributed to establishing a relationship between fluoride loss rates and average expected ultimate cell life. This relationship is shown. Several features have been introduced into SPE fuel cells and SPE electrolyzers such that applications requiring greater than or equal to 100,000 hours of life can be considered. Equally important as the ultimate life is the voltage stability of hydrogen-oxygen fuel cells and electrolyzers. Here again the features of SPE fuel cells and SPE electrolyzers have shown a cell voltage stability in the order of 1 microvolt per hour. That level of stability has been demonstrated for tens of thousands of hours in SPE fuel cells at up to 500 amps per square foot (ASF) current density.

40910 (N–90-20454, pp. 171-180) **Corrosion testing of candidates for the alkaline fuel cell cathode.** Singer, J.; Fielder, W.L. National Aeronautics and Space Administration, Cleveland, OH (USA). Lewis Research Center. Dec 1989. (NASA-CP–3056;E–4708;NAS–1.55:3056;CONF-8904196–: 2. space electrochemical research and technology conference, Cleveland, OH (USA), 11-13 Apr 1989). In *Space electrochemical research and technology (SERT), 1989.* Available from NTIS, PC A16/MF A02.

Current/voltage data was obtained for specially made corrosion electrodes of some oxides and of gold materials for the purpose of developing a screening test of catalysts and supports for use at the cathode of the alkaline fuel cell. The data consists of measurements of current at fixed potentials and cyclic voltammograms. These data will have to be correlated with longtime performance data in order to fully evaluate this approach to corrosion screening. Corrosion test screening of candidates for the oxygen reduction electrode of the alkaline fuel cell was applied to two substances, the pyrochlore Pb2Ru2O6.5 and the spinel $NiCo_2O_4$. The substrate gold screen and a sample of the IFC Orbiter Pt-Au performance electrode were included as blanks. The pyrochlore data indicate relative stability, although nothing yet can be said about long term stability. The spinel was plainly unstable. For this type of testing to be validated, comparisons will have to be made with long term performance tests.

40911 (N–90-21469) **O2 reduction at the IFC orbiter fuel cell O_2 electrode.** Fielder, W.L.; Singer, J. National Aeronautics and Space Administration, Cleveland, OH (USA). Lewis Research Center. Apr 1990. 15p. (NASA-TM–102580;E–5411;NAS–1.15:102580). Available from NTIS, PC A03/MF A01.

O2 reduction Tafel data were obtained for the IFC Orbiter fuel cell O2 electrode (Au-10 percent Pt catalyst) at temperatures between 24 and 81 C. BET measurements gave an electrode surface area of about 2040 sq cm per sq cm of geometric area. The Tafel data could be fitted to three straight line regions. For current densities less than 0.001 A/sq cm, the slope was essentially independent of temperature with a value of about 0.032 V/decade. Above 0.001 A/sq cm, the two regions, designated in the present study as the 0.04 and 0.12 V/decate regions, were temperature dependent. The apparent energies of activation for these two regions were about 9.3 and 6.5 kcal/mol, respectively. Tafel data (1 atmosphere O2) were extrapolated to 120 C for predicting changes in overpotential with increasing temperature. A mechanism is presented for O2 reduction.

32 ENERGY CONSERVATION, CONSUMPTION, AND UTILIZATION

3201 Buildings

Refer also to citation(s) 40343

40912 (CONF-900833–4) **Direct installation of lighting measures in small nonresidential buildings.** Gettings, M.; MacDonald, M. Oak Ridge National Lab., TN (USA). [1990]. 7p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC05-84OR21400. From ACEEE summer study on energy efficiency in buildings; Pacific Grove, CA (USA); 26 Aug - 1 sep 1990. Order Number DE90013384. Available from NTIS, PC A02/MF A01 - OSTI.

Fast-paced changes are occurring in the way utilities offer demand side management (DSM) services to their customers. Recent research on the methods for offering installation of 34W fluorescent lamps in nonresidential buildings showed that "Direct Installation," where the lamps are installed at little or a nominal charge, was being tested and found valuable for commercial customers. In our research we (1) evaluated the costs and savings – including field measurements of energy use – for utility offering such a service in Texas, (2) established that engineering estimates of savings were valid if the condition of existing lamps was accounted for, (3) reviewed cost and savings estimates from a second utility in California, (4) identified issues that should be considered by other utilities wishing to implement such a program, and (5) identified key features of such programs that should be considered when conducting an evaluation of savings or comparing benefits between programs. A principal conclusion from the previous research was that direct installation is an important DSM approach for the 1990's. The paper discusses the previous work so that specific results related to the direct installation approach can be considered by states and utilities wishing to consider this approach. The paper will also compare our conclusions with current utility DSM efforts to install replacement 34W fluorescent lamps in the Northeast. 7 refs.

40913 (CONF-900833–5) **Exploratory investigation of a new modeling approach and an energy index for multifamily buildings in the Pacific Northwest.** MacDonald, M.; White, D. Oak Ridge National Lab., TN (USA). [1990]. 10p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC05-84OR21400. From ACEEE summer study on energy efficiency in buildings; Pacific Grove, CA (USA); 26 Aug - 1 sep 1990.

Order Number DE90013834. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

In this study, a sinusoidal model of empirical energy data for all-electric multifamily (MF) buildings in the Pacific Northwest was developed. The sinusoidal model uses short-term submetered heating energy data to model seasonal heating energy use for MF buildings. The model gives reasonable estimates of annual heating energy use for three older buildings for the pre-retrofit and post-retrofit cases, and less reasonable answers for heating energy savings. The estimates of heating energy and heating energy savings for the three buildings were based on starting values for three free parameters of the model developed for one building. After the starting parameters are determined, only one parameter is modified for other buildings and conditions, based on the monthly fraction of energy used for heating in January. The heating fraction in January is determined from submetered heating energy for that month. Thus, metering studies would need to monitor heating energy use for January and collect monthly data from the utility billing meters for a particular building, to obtain the data needed for this model to provide an annual heating energy estimate. Further research is needed to verify the potential benefits of this model. A two-parameter index for representation of MF energy use is also presented. This index helps keep space heating energy in perspective relative to other energy use in MF buildings and should aid in comparing the energy performance of MF buildings. 12 refs., 2 figs., 1 tab.

40914 (CONF-9009116–2) **A tutorial on some sampling techniques used for measuring radon levels.** Wright, T. Oak Ridge National Lab., TN (USA). [1990]. 3p. Sponsored by U.S. Department of Defense; U.S. DOE Energy Research. DOE Contract AC05-84OR21400. From Spectrum '90: radioactive waste technologies, decontamination, decommissioning and hazardous wastes; Knoxville, TN (USA); 30 Sep - 4 oct 1990. Order Number DE90011312. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

This paper supplements the paper by Bertini, Dudney, Wilson, and Wright (1990) which serves as a background for the statistical methods discussed here. In this paper we assume a general setting because the issues discussed are very common, but the applications are often misunderstood. At each facility the objective is to identify all units that have radon levels above the US Environmental Protection Agency's recommended guideline level, and to perform remedial work in those units with high levels of radon. In the remainder of this paper we focus on three sampling related issues: determination of minimum sample size n, probability of picking up at least one hot unit in the sample, and determination of upper confidence bounds given no observed hot units. 4 refs., 3 tabs.

40915 (DOE/BP/91489–1) **The Northwest wall moisture study: A field study of excess moisture in walls and moisture problems and damage in new Northwest homes.** Tsongas, G. Portland State Univ., OR (USA). Jun 1990. 51p. Sponsored by U.S. DOE Bonneville Power Administration. DOE Contract AC79-88BP91489. Order Number DE90014155. Available from NTIS, PC A04/MF A01 - OSTI; GPO Dep.

The Pacific Northwest Electric Power Planning and Conservation Act, signed into law December 5, 1980, mandated regionwide energy conservation practices. Under the act, the Bonneville Power Administration (BPA) is required to identify and implement cost-effective electric energy options and programs for the Pacific Northwest. The Residential Technology Section in the Division of Resource Management supports current residential energy conservation programs and designs and conducts various research and development projects, of which this project is one. Concern has been expressed about whether the higher levels of wall insulation in new, energy-efficient homes causes unacceptably high levels of moisture or moisture damage within walls. This study was conducted in three phases. In the first phase, a pool of homes built to the Model Conservation Standards (MCS) were identified in the fall of 1986. Letters explaining the project were sent to 257 homeowners. The owners of 124 homes agreed to participate. Each of the 124 houses was inspected and the occupants were interviewed. An effort was made to select houses likely to have the worst moisture problems. Wall cavities of 86 selected homes were opened during the winter of 1987 since the potential for moisture condensation is greatest in the winter. In the second phase, 28 homes with very wet walls in the first phase were reopened during the summer of 1988 to check for drying. In the third phase, the 16 homes that still had wet walls in the summer of 1988 were reopened again in the winter of 1989. Moisture mitigation measures were installed in these homes and they were reopened again in the spring. Field data was collected during each phase and analyzed to produce this report. 18 refs., 1 fig., 14 tabs.

40916 (IfB-F–706) **Principles and possibilities of ecological construction methods in house building.** Bade, K.; Zapke, W.; Brocher, E.; Deters, K.; Blomensaht, F.; Friedrich, H. Institut fuer Bauforschung e.V., Hannover (Germany, F.R.); Sozialministerium des Landes Niedersachsen, Hannover (Germany, F.R.). Dec 1988. 178p. (In German). Available from Copy held by UB/TIB Hannover.

The foundations for environmentally beneficial and ecological construction methods have to be laid when establishing the plans for development and have to be realized efficiently. As the exapmples mentioned show there is a possibility to put the theoretical knowledge successfully into practise. Great sucess has been achieved with the realization of ecologically orientated housing schemes when given general requirements have been fulfilled in a highly imaginative manner by architects and are supplemented by private law arrangements between the clients for whom they are built. It also revealed that such housing schemes have to be supported by the clients as ecological measures not only concern the construction but also the living in such houses and their maintenance and above all the associated residential area. (orig.).

40917 (LBL–28273) **Radiant transfer due to lighting: An example of symbolic model generation for the simulation problem analysis kernel.** Sowell, E.F. (California State Univ., Fullerton, CA (USA). Dept. of Computer Science); Nataf, J.-M.; Winkelmann, F. Lawrence Berkeley Lab., CA (USA). Jan 1990. 51p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC03-76SF00098. (CONF-900182–2: Computer simulation 1990 multiconference, San Diego, CA (USA), 17-19 Jan 1990). Order Number DE90013360. Available from NTIS, PC A04/MF A01 - OSTI; GPO Dep.

The Simulation Problem Analysis Kernel (SPANK) is a simulation environment under development at Lawrence Berkeley Laboratory. A principal departure from other simulation environments is that system models are constructed from submodel objects that are defined without prescribed input or output interfaces, yielding greater modeling flexibility. Also, graph theoretic techniques are employed to determine the solution sequence, including reduction of the iterative problem size. In this paper we show one role of symbolic manipulation in SPANK processing, namely automatic generation of submodels using the MACSYMA™ package. This is demonstrated in the context of steady state radiant and convective heat transfer in a room with a fluorescent lighting system, and then in the corresponding dynamic context. Submodel definition and generation are described, followed by the solution of several interesting problems defined with the submodels. 11 refs.

40918 (PB–90-210477/XAB) **Load management in electrically heated buildings: Influence of increased indoor air temperature during the night on heat load and heat requirement.** Adamson, B. Statens Raad foer Byggnadsforskning, Stockholm (Sweden). ©1989. 78p. Available from NTIS, PC A05/MF A01.

Strategies aiming at a reduction of electricity consumption, for heating residential houses, during daytime (06.00-22.00) by raising the heating set point during nighttime have been studied by computer simulations. The conclusions are: The energy requirement for heating during the day (06.00-22-00) can be reduced to 50% by raising the temperature 4 C during the night. The total energy requirement raises 15% compared with the day set point during both day and night; the maximum heat load raises 2-4 times compared with constant heating set point; a strategy with the heating set point decreased to 18 C during the day and increased to 22 C during the night gives 1-1.5 C lower sensible temperatures during a cloudy and cold day than the strategy with 20 C day and night.

40919 (PB–90-213638/XAB) **Policies and criteria for heating, ventilating, and air-conditioning systems in federal buildings. Final report.** National Research Council, Washington, DC (USA). Building Research Board. Mar 1990. 68p. Available from NTIS, PC A04/MF A01.

The Building Research Board Committee on Heating, Ventilating, and Air-Conditioning Criteria was asked to review federal construction agencies' general policies and criteria regarding the selection, procurement, and operation of HVAC systems. The committee examined the entire process by which HVAC systems are acquired and operated by federal agencies, as well as the technical criteria and guidelines published by the agencies. The report presents the committee's recommendations for improvements in development and use of HVAC criteria, the design process for HVAC systems, the installation process, and maintaining HVAC systems. Agency organizational considerations were also addressed.

40920 (PB–90-220823/XAB) **In-house performance of new-technology woodstoves.** McCrillis, R.C. Environmental Protection Agency, Research Triangle Park, NC (USA). Air and Energy Engineering Research Lab. 1990. 16p. (EPA–600/D-90/026). Available from NTIS, PC A03/MF A01.

The paper describes the results of several field studies undertaken in North America since 1985 to establish the emission rates of typical, uncontrolled, conventional technology woodstoves and the degree of emission control achieved by newer woodstoves designed to reduce the emission of unburned organics. The new stoves, employing either catalytic or noncatalytic secondary combustion features, while reducing emissions, do not achieve the expected emission reduction. Studies during the northern winter of 1988-89 showed that emission control was gradually improving, but they also showed that some woodstove models were experiencing degraded emission control performance after only a few months use. Use of wood as a residential heating fuel increased markedly in the U.S. during the 1970s in response to an increase of fossil fuel costs. Most of the increase represented wood burned in air-tight parlor stoves which are generally operated in an air-starved condition leading to low combustion efficiency and the release of substantial quantities of unburned organics into the atmosphere. Use of wood as a residential house heating fuel in the U.S. has been estimated to contribute up to 90% of the polynuclear organic material attributable to stationary sources and 50% from all sources.

40921 (PB–90-871179/XAB) **Thermal insulation for buildings. September 1982-May 1990 (A Bibliography from the COMPENDEX data base). Report for September 1982-May 1990.** National Technical Information Service, Springfield, VA (USA). Jun 1990. 133p. Available from NTISPC N01/MF N01.

Supersedes PB–88-869961.

This bibliography contains citations concerning materials used for the thermal insulation of buildings. Consumer acceptance of materials and weatherproofing options are included. Insulation in new and retrofitted buildings is discussed. Residential buildings, earth sheltered structures, greenhouses, and animal houses are among the structures studied. Infrared thermal sensing of heat loss, insulation placement, multilayer partition walls, and insulating windows are briefly considered. (This updated bibliography contains 299 citations, 55 of which are new entries to the previous edition.)

40922 (SBI-R–208) **Computerized management of heating and ventilation systems.** Aggerholm, S. Statens Byggeforskningsinstitut, Hoersholm (Denmark). 1990. 48p. (In Danish). Available from Statens Byggeforskningsinstitut, Postboks 119, DK-2970 Hoersholm, Denmark. DKK.91.

EFP-85; EFP-86.

To investigate the function of the programmable controllers a survey of the control systems has been carried out in 7 buildings with either programmable standard units or BMS. The survey consisted in testing the control equipment followed by a detailed registration of the running conditions, and an assessment of how the control worked together with the plants in the buildings. The registrations showed that the limitation of the achieved control often is a difference in room temperature in rooms within the same zone, even though they are set at the same temperature. The differences appear during night set back, at the beginning of the use period, and in the whole use period. Simulations show that in most buildings no considerable increase in the energy saving is achieved by setting the minimum night temperature to 14 deg. C instead of 16 deg. C., and that the greater part of the saving is achieved with the minimum temperature set at 18 deg. C. The simulations also show that in some buildings considerable extra savings can be achieved by individual night set back if there are considerable differences in the use period of the rooms. In buildings with large heat loss the comfort can be improved in summer by cooling the building at night with outdoor air. The investigation shows that it is possible to achieve further energy savings and comfort improvements by introducing new and more detailed control strategies by the aid of programmable controllers. (AB).

40923 **Energy-efficient buildings.** Rosenfeld, A.H.; Hafemeister, D. *Scientific American (USA)*, 258(4): 78-85 (Apr 1988).

Since the 1973 oil famine the US has learned to save 45 billion dollars a year by making homes and offices more energy efficient. Now an oil glut has led to complacency. For 50 to 100 years the nation will be paying energy bills for buildings going up today. This paper discusses innovative technologies and policies can could cut 50 billion dollars a year from these energy bills. Some of these technologies are solar-assisted building designs, superinsulated houses, fluorescent lighting systems, insulated windows, home appliance improvements, and use of off-peak power.

40924 **Strategies for energy use.** Gibbons, J.H.; Blair, P.D.; Gwin, H.L. *Scientific American (USA)*, 261(3): 136-143 (Sep 1989).

Nuclear power, solar cells, wind, and tide will all have roles in supplying energy for growth and development without aggravating the greenhouse effect. Yet exotic new energy sources alone cannot meet the challenge. Significant improvement in the efficiency of energy use is the real hope. Energy efficiency can reconcile environmental concerns with economic development for all nations. It can stretch energy supplies, slow climatic changes, and buy time to develop alternative energy resources. After a review of conventional fuel consumption, the paper discusses the opportunities available for energy efficiency in automobiles, houses, refrigerators, gas furnaces, and air conditioning.

3202 Transportation

Refer also to citation(s) 40895, 40896, 41270, 41816

40925 (PB–90-206228/XAB) **Financial review: Member jurisdictions of the washington metropolitan area transit authority. Final report.** Urban Mass Transportation Administration, Washington, DC (USA). Feb 1987. 149p. Available from NTIS, PC A07/MF A01.

The report provides a snapshot of the current financial condition of the jurisdictions who contribute funds to the Washington Metropolitan Area Transit Authority (WMATA). The document serves as a good introduction to the factors any jurisdiction has to look at when investing in transportation facilities. After reviewing the funding mechanisms and debt service already being borne by WMATA to set the context, the document examines the financial condition of each of the WMATA major funding contributors in detail. Each jurisdiction's writeup includes its credit rating from Moody's and Standard & Poor's, its current mass transit service revenue commitment to the transit system, its economic situation, its current tax base and taxing rate restrictions, the composition of its general fund, its borrowing history (Both in terms of amounts borrowed and from who), and projected expenditures. Although oriented toward large projects, the document can introduce assessment of ability to pay to governments of any size.

40926 (PB–90-206483/XAB) **Evaluation of Travel Demand Management (TDM). Measures to relieve congestion.** Kuzmyak, J.R.; Schreffler, E.N. COMSIS Corp., Silver Spring, MD (USA). Feb 1990. 160p. Available from NTIS, PC A08/MF A01.

The report summarizes the results of a research study to investigate the effectiveness of Travel Demand Management (TDM) programs. The investigation consisted of the evaluation of a number of existing TDM programs located throughout the United States. The study directly measured the quantitative impact of the

TDM programs on reducing low-occupancy vehicle trips. The approach was to evaluate each program as a separate case study, using the same set of evaluation tools and guidelines. Vehicle volumes and mode choice evaluations of the programs were prepared whenever data was available. Comparisons were made and inferences drawn between sites that do have a TDM program and those sites that do not. The report presents these case studies as well as overall conclusions on the impact that TDM has on reducing the number of low-occupancy vehicle trips.

40927 (PB–90-207325/XAB) **Coordinating special transportation services in Louisiana (without appendices). Final report.** Urban Systems, Inc., New Orleans, LA (USA). Dec 1988. 209p. Available from NTIS, PC A10/MF A02.

See also PB–89-191035.

The report describes a pair of demonstrations undertaken by the Louisiana Department of Transportation and Development to improve services to special transportation users, and serve as a planning model for other operators in the state. One demonstration served an urban area (Orleans Parish); one served a rural area (Tangipahoa Parish). Both were designed to try and minimize capital costs and operating expenses by judicious use of coordination. Coordination alternatives considered included brokerage, consolidation, contract service, ad hoc service, central referral service, user-side subsidies, timesharing, ridesharing, and various kinds of joint purchasing arrangements. Considering their local conditions, joint purchasing of fuel appeared particularly effective as a cost cutting technique.

40928 (PB–90-207374/XAB) **Best practices in specialized and human services transportation coordination. Final report.** Center for Systems Program Development, Inc., Washington, DC (USA). Jul 1989. 245p. Available from NTIS, PC A11/MF A02.

The report provides detailed case studies of exemplary programs providing or promoting coordinated transportation services to elderly, handicapped, or special users. Approaches described include providing services through a community action agency, a brokerage organization, a public county or regional paratransit system, a private nonprofit system, and a volunteer program. Four regional and state level coordination programs are also discussed in depth. All programs included have overcome at least two barriers to coordination. An compilation of Federal funding programs having a transportation component, noting their authorizing legislation, activities, funding levels, and application procedures, is also included.

40929 (PB–90-208299/XAB) **Evaluation of the optimized policies for adaptive control strategy. Final report.** Farradyne Systems, Inc., Rockville, MD (USA). May 1989. 133p. Available from NTIS, PC A07/MF A01.

The OPAC strategy is an on-line traffic signal control algorithm designed to optimize the performance of traffic signals at isolated intersections using delay as the performance criterion. OPAC-RT is a traffic signal control system which implements the OPAC strategy in real time. The system uses traffic data collected from detectors located well upstream (400 to 600 ft) of the stop bar on all approaches to an intersection. Optimum signal timing is determined using minimum and maximum green constraints and does not require a fixed cycle length. The report describes three field tests of the on-line OPAC strategy. The results indicate that OPAC performs better than well timed actuated signals, particularly at greater demand levels.

40930 (PB–90-209313/XAB) **Roadway congestion in major urban areas 1982 to 1987. Interim report, September 1987-February 1990.** Hanks, J.W.; Lomax, T.J. Texas A and M Univ., College Station, TX (USA). Texas Transportation Inst. Oct 1989. 93p. (TTI–2-10-88-1131-2). Available from NTIS, PC A05/MF A01.

See also PB–89-211049.

The research report studied 39 urban areas. An assessment of the freeway and major street operating conditions was performed in seven Texas and 32 other urban areas in the continental United States. In addition, the analyses from 1982 to 1986 were updated to include 1987 urban area data. Vehicle-miles of travel and lane-miles of roadway data were collected from a variety of sources to estimate congestion on the freeway/expressway and principal arterial street systems. The values for each system were combined into a roadway congestion index used to rank mobility in each urban area on a relative scale. An analysis of the cost of this congestion was performed using travel delay, increased fuel consumption and increased auto insurance premiums as the economic analysis factors. The economic cost to the urban area, and to the individual resident, was estimated.

40931 (PB–90-209321/XAB) **Impacts of carpool utilization on the Katy Freeway Transitway 42-month after evaluation. Interim report, September 1984-September 1989.** Hawkins, H.G.; Christiansen, D.L. Texas A and M Univ., College Station, TX (USA). Texas Transportation Inst. Sep 1989. 68p. (TTI–2-10-85-484-11). Available from NTIS, PC A04/MF A01.

See also PB–89-127898.

A major commitment has been made in the Houston area to develop physically separated transitways in the medians of freeways. The lanes are reserved for high-occupancy vehicles. Phase 1 of the first completed transitway opened on the Katy Freeway (I-10) in October 1984. The research study, funded jointly by the Metropolitan Transit Authority of Harris County and the Texas State Department of Highways and Public Transportation, was initiated in order to conduct a comprehensive analysis of the effects of permitting carpools to utilize the transitway. The report documents data collected in October 1988, 3.5 years after carpool utilization of the transitway began. The report compares the 1988 data to similar data collected before carpool utilization was permitted (March 1985) and after carpool utilization was permitted (April 1986, October 1987). These comparisons address numerous concerns and provide an indication of the effectiveness of allowing carpools on the transitway.

40932 (PB–90-216748/XAB) **Issues in the shift from regional to local provision of bus service. Final report.** Ulberg, C.G. National Research Council, Washington, DC (USA). Transportation Research Board. Apr 1990. 35p. (TRB/NCTRP/SYN–14). Available from NTIS, PC A03/MF A01.

Since 1975 a number of local governments have augmented or replaced transit service previously provided by a regional transit agency. The report of the Transportation Research Board describes the various issues that will have an effect on the decision by a local agency to operate transit service. The issues include funding and organizational environment, costs, quality of service, politics, and impact on the regional operator. Because most of the shifts in service provision have taken place within the last six years, no conclusions as to their long-term implications can be drawn.

40933 (PB–90-219882/XAB) **Comparison, contrast, and critique of four commuter coordination systems. Final report.** Margulies, N.; Baker, J. California Univ., Irvine, CA (USA). Graduate School of Management. Feb 1990. 459p. Available from NTIS, PC A20/MF A03.

Portions of this document are not fully legible.

The review establishes a general understanding of the concept of organizational effectiveness by summarizing major models of effectiveness presented in literature, and specifies a useful framework for analyzing organizational effectiveness in the 4 commuter coordination systems documented in the report. A model of interorganizational relationships was developed as a result of the interviews and was employed to evaluate the strengths and weaknesses of each organizational form and to generate an ideal type for future rideshare organizations. Legislation legitimizing the commuter coordination service was found to be a critical factor in the ability of the agencies to impact their environments.

40934 (SAND–90-0078) **Hypersonic Arbitrary-Body Aerodynamics (HABA) for conceptual design.** Salguero, D.E. Sandia National Labs., Albuquerque, NM (USA). 15 Mar 1990. 103p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. Order Number DE90014750. Available from NTIS, PC A06/MF A01 - OSTI; GPO Dep.

The Hypersonic Arbitrary-Body Aerodynamics (HABA) computer program predicts static and dynamic aerodynamic derivatives at hypersonic speeds for any vehicle geometry. It is intended to be used during conceptual design studies where fast computational speed is required. It uses the same geometry and hypersonic aerodynamic methods as the Mark IV Supersonic/Hypersonic Arbitrary-Body

Program (SHABP) developed under sponsorship of the Air Force Flight Dynamics Laboratory; however, the input and output formats have been improved to make it easier to use. This program is available as part of the Department 9140 CAE software.

3203 Industrial and Agricultural Processes

Refer also to citation(s) 40324, 40405, 40586, 40894, 41064, 41316, 41555

40935 (EUR–11238) **Pressing of beet pulp to reduce its water content to a minimum in order to make savings in drying costs. Demonstration project.** Socode, S.C. Commission of the European Communities, Luxembourg (Luxembourg). 1987. 56p. (In FR, EN). Contract No E/361/81. Available from NTIS (US Sales Only), PC A04/MF A01.

The project involves the use of a high-performance press to reduce the water content of the beet pulp to a minimum, and a low-temperature drying unit using waste heat from the sugar factory to dry the beet pulp without primary energy. A saving of 1 000 toe is expected for an annual production of 5 500 tonnes of dry pulp. The major risk in the project, which was pointed out when the project was submitted in 1981, was the possibility of a significant drop in oil prices which would make the project less profitable or even totally unprofitable. This risk now forms a major setback to the project.

40936 (PB–90-591300/XAB) **Resource Conservation Recovery Act notification data file. Data file.** Environmental Protection Agency, Washington, DC (USA). Office of Solid Waste. Mar 1990. mag ta Available from NTISSubscription.

Supersedes PB–88-913800. Source tape is in the EBCDIC character set. This restricts prep. to 9 track, one-half inch tape only. Identify recording mode by specifying density only. For price at 6250 bpi density, call NTIS Computer Products. Price includes documentation, PB–90-214388. Avail. on subscription, North American Continent price $3560.00/year; indiv. issue $890.00; all others write for quote. Issued quarterly.

The file contains data compiled for the Resource Conservation Recovery Act. Notification of Hazardous Waste Activity, EPA Form 8700-12 was used to collect the data. The file was updated with information compiled from the application for a Hazardous Waste Permit, EPA Form 3510-3. The data includes names and addresses of the facility owner and operator, as well as the facility contact name and number. The data indicates whether a facility is a generator, treatment/storer/disposer, and/or transporter of hazardous waste. There is also a listing of code numbers of waste handled taken from 40CFR, Part 261. The tapes do not contain enforcement sensitive data. Users should also note that Part A information such as design capacity, and other quantity information is only estimated and does not represent a true value for the represented facilities.

40937 (PB–90-868449/XAB) **Solid-waste reclamation and recycling: Plastics. February 1971-March 1990 (A Bibliography from the NTIS data base). Report for February 1971-March 1990.** National Technical Information Service, Springfield, VA (USA). May 1990. 117p. Available from NTISPC N01/MF N01.

Supersedes PB–89-863880.

This bibliography contains citations concerning the recovery of plastic wastes. Urban and industrial recycling programs are discussed. The decomposition of plastics into reusable chemicals and the use of recycled plastic in new products are discussed. The economics of plastics recycling programs and participation in them are covered briefly. (This updated bibliography contains 214 citations, 72 of which are new entries to the previous edition.)

40938 (PB–90-869504/XAB) **Forging processes: Lubrication. January 1970-January 1990 (A Bibliography from the COMPENDEX data base). Report for January 1970-January 1990.** National Technical Information Service, Springfield, VA (USA). May 1990. 76p. Available from NTISPC N01/MF N01.

This bibliography contains citations concerning lubricants used in the forging industries to reduce tool wear and help prevent buildup formation on tools. Methods developed to select and evaluate forging lubricants for both safety and effectiveness are described. Low-pollution level, water-based synthetic lubricants, and non-corrosive, graphite-free lubricants are described. Mathematical modelling and finite element analyses used to determine lubricant dosage and distribution are included. (Contains 189 citations fully indexed and including a title list.)

40939 (PB–90-871997/XAB) **Ferrography: Wear analysis and monitoring of lubricants and hydraulic fluids. January 1974-February 1990 (A Bibliography from FLUIDEX data base). Report for January 1974-February 1990.** National Technical Information Service, Springfield, VA (USA). Jun 1990. 86p. Available from NTISPC N01/MF N01.

Supersedes PB–88-854278.

This bibliography contains citations concerning the developments and evaluation of ferrographic wear analysis and monitoring of industrial lubricants and hydraulic fluids. Ferrographic condition monitoring of gears, bearings, diesel engines, gas turbines, jet engines, and hydraulic systems are discussed. Ferrographic analytical techniques include online, direct read, real time, and quantitative analysis. (This updated bibliography contains 233 citations, 29 of which are new entries to the previous edition.)

40940 (TNO-IGMB-I–89-414) **Investigation of energy saving measures and equipment: Part 1.** Rouwen, W. Instituut voor Graan, Meel en Brood TNO, Wageningen (Netherlands). Aug 1989. 29p. Project TNO-IGMB 382118. Order Number DE90797096. Available from NTIS (US Sales Only), PC A03/MF A01.

As a result of research on the energy consumption in the bakeries, the bread industry and confectioneries the IGMB-TNO (Cereals, Flour and Bread Institute of the Netherlands Organization for Applied Scientific Research) investigated the possibilities of applicated and to be applicated gas burners. The furnaces of the above mentioned sectors cause considerable energy losses, because of a wrong chosen capacity, application or adjustment of the burner. An overview is presented of the applicated burners, the failures in the applications and the possibilities to adjust existing burners to the required capacity of the furnace. Also attention is paid to recent developments with regard to burners and burner adjustments. The effects of capacity and adjustments on the furnace temperature are indicated. 8 figs., 1 tab., 9 refs.

40941 **Strategies for manufacturing.** Frosch, R.A.; Gallopoulos, N.E. *Scientific American (USA)*, 261(3): 144-152 (Sep 1989).

Can the industrial way of life be maintained without exhausting resources, generating unmanageable amounts of waste and poisoning the environment? The paper discusses how wastes from one industry can serve as the raw materials for another, thus providing an industrial ecosystem characterized by dematerialization and closed-system manufacturing. The paper uses three examples to illustrate an industrial ecosystem: the conversion of petroleum derivatives to plastics, the conversion of iron ore to steel, and the refining and use of platinum-group metals as catalysts.

3206 Municipalities and Community Systems

Refer also to citation(s) 40324, 40403, 40561, 40601, 40937

40942 (CONF-861033–1) **Densified refuse derived fuel: An alternative energy source.** Ohlsson, O. (Argonne National Lab., IL (USA)); Daugherty, K.E.; Venables, B.J. Argonne National Lab., IL (USA). [1986]. 5p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract W-31109-ENG-38. From 9. world energy engineering congress; Atlanta, GA (USA); 21-24 Oct 1986. Order Number DE90013668. Available from NTIS, PC A02/MF A01 - OSTI.

The objective of this research effort is to produce an environmentally acceptable, chemically/biologically stable, and storable densified refuse derived fuel (dRDF) pellet. To accomplish this, a suitable binder(s) must be used. Over 150 binders were investigated by a laboratory screening procedure. Thirteen binder/binder combinations of the initial group of 150 binders were selected for further pilot plant studies. Approximately seven tons of RDF from Ames, Iowa and Refcom, Pompano Beach, Florida were pelletized in the summer-1985 in a series of experiments at the Jacksonville, Florida Naval Air Station using these binder. The pelletized dRDF was then subjected to a battery of chemical and physical tests. Results to date and work to be accomplished during the next fiscal year will be discussed. 2 figs., 2 tabs.

40943 (NYSERDA–90-6-Vol.1) **Development and pilot test of an intensive municipal solid waste recycling system for the Town of East Hampton: Volume 1: Final report.** Commoner, B.; Frisch, M.; Pitot, H.A.; Quigley, J.; Stege, A.; Wallace, D.; Webster, T. Queens Coll., Flushing, NY (USA). Center for the Biology of Natural Systems. Feb 1990. 290p. Sponsored by New York State Energy Research and Development Authority. Available from OSTI; New York State Energy Research and Development Authority, Two Rockefeller Plaza, Albany NY 12223.

This report presents the results of a project to design and test a new type of trash disposal system for the Town of East Hampton, Long Island: the Intensive Recycling System. The system is intended to serve as the Town's primary means of regular trash disposal. The Intensive Recycling System is based on separation of regular trash, by households and commercial establishments, into four fractions: (1) food garbage and soiled paper; (2) paper/cardboard; (3) metal cans/glass bottles; (4) non-recyclables. Fraction 1, together with yard waste, is processed at a compost facility, yielding marketable compost. Fractions 2 and 3 are processed by a materials recovery facility (MRF) into marketable products: several grades of paper and cardboard; aluminum cans; tin cans; scrap metal; and color-sorted crushed glass (cullet). The non-recyclable components (fraction 4) and misclassified components rejected during processing are consigned to a landfill. This document is Volume 1 of two volumes. 75 refs., 24 figs., 81 tabs.

40944 (NYSERDA–90-6-Vol.2) **Development and pilot test of an intensive municipal solid waste recycling system for the Town of East Hampton: Volume 2, Appendices: Final report.** Commoner, B.; Frisch, M.; Pitot, H.A.; Quigley, J.; Stege, A.; Wallace, D.; Webster, T. Queens Coll., Flushing, NY (USA). Center for the Biology of Natural Systems. Feb 1990. 282p. Sponsored by New York State Energy Research and Development Authority. Available from OSTI; New York State Energy Research and Development Authority, Two Rockefeller Plaza, Albany, NY 12223.

This report presents the results of a project to design and test a new type of trash disposal system for the Town of East Hampton, Long Island: the Intensive Recycling System. The system is intended to serve as the Town's primary means of regular trash disposal. The Intensive Recycling System is based on separation of regular trash, by household and commercial establishments, into four fractions: (1) food garbage and soiled paper; (2) paper/cardboard; (3) metal cans/glass bottles; (4) non-recyclables. Fraction 1, together with yard waste, is processed at a compost facility, yielding marketable compost. Fractions 2 and 3 are processed by a materials recovery facility (MRF) into marketable products: several grades of paper and cardboard; aluminum cans; tin cans; scrap metal; and color-sorted crushed glass (cullet). The non-recyclable components (fraction 4) and misclassified components rejected during processing are consigned to a landfill. This document is Volume 2 of two volumes and contains the appendix for Volume 1.

40945 (PB–90-219585/XAB) **Quantification of heat losses through structural supports for shallow-trench heat-distribution systems.** Fang, J.B. National Inst. of Standards and Technology (NEL), Gaithersburg, MD (USA). Building Environment Div. Oct 1989. 106p. (NISTIR–89/4134). Available from NTIS, PC A06/MF A01.

Shallow trench heat distribution systems generally contain numerous structural supports which are often in direct contact with hot carrier pipes and form highly conductive heat flow paths, and are major sources of heat loss. Quantification of the heat loss caused by thermal bridges due to pipe supports and prediction of thermal fields were achieved using three finite element computer models of two-dimensional, steady-state heat conduction within a rectangular concrete trench containing two insulated pipes with and without pipe supports, and the surrounding earth. The theoretical basis, computational scheme, and the data input and outputs of the developed computer programs for sample calculations are described. Two trench pipe support systems studied include the horizontal anchoring and the vertical supports. The thermal bridges due to structural supports contribute approximately 17 times more to total heat loss compared to similar pipes with no pipe supports.

3209 Education and Public Relations

Refer also to citation(s) 40887

33 ADVANCED PROPULSION SYSTEMS

40946 (CPIA-PUBL–515-VOL-1) **The 1989 JANNAF Propulsion Meeting, volume 1.** Eggleston, D.S.; Strange, K.L. Johns Hopkins Univ., Baltimore, MD (USA). May 1989. vp. (CONF-8905134–: JANNAF propulsion meeting, Cleveland, OH (USA), 22-25 May 1989). Available from NTIS, PC A25/MF A04.

Specific subjects discussed include space shuttle solid rocket motor, motor insulation, bipropellant engines, space propulsion, orbital propellant feed systems, and electric propulsion.

3301 Internal Combustion Engines

Refer also to citation(s) 40587

40947 (LBL–28944) **An interactive microcomputer-based kiosk providing energy efficient building design information.** Sullivan, R.; Wilde, M.; Selkowitz, S. Lawrence Berkeley Lab., CA (USA). Apr 1990. 10p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC03-76SF00098. (CONF-900410–4: International conference on low-temperature electronics: semiconducting–superconducting, Berkeley, CA (USA), 23-26 Apr 1990). Order Number DE90014036. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Lawrence Berkeley Laboratory (LBL), with support from Southern California Edison (SCE), a major utility in the Los Angeles area, has developed a prototype electronic interactive Energy Information Kiosk: a personal computer with touch screen provides information linked to video images stored on an optical disc. The kiosk uses text, graphics, animation, sound, and video to communicate effectively. This project's goals were: to demonstrate SCE's commitment to provide relevant, useful energy services to its customers; to highlight specific incentive programs; to provide users with contacts to people and resource materials at SCE; and most importantly, to provide technical guidance for building design professionals who want to improve the energy efficiency of buildings. 4 refs., 8 figs.

40948 (PB–90-868456/XAB) **Lubrication and wear of pistons and piston rings. January 1983-February 1990 (A Bibliography from FLUIDEX data base). Report for January 1983-February 1990.** National Technical Information Service, Springfield, VA (USA). May 1990. 32p. Available from NTISPC N01/MF N01.

Supersedes PB–88-866454.

This bibliography contains citations concerning the lubrication and wear of pistons and piston rings. Topics include friction characteristics, service life testing, materials testing, and design of piston rings and liners for various applications. The behavioral characteristics of lubricated piston rings are analyzed and performance evaluations of various lubricants are presented. (This updated bibliography contains 61 citations, 11 of which are new entries to the previous edition.)

40949 (PB–90-871005/XAB) **Ceramics technology: Automotive gas turbine engine component applications. January 1976-April 1990 (A Bibliography from the NTIS data base). Report for January 1976-April 1990.** National Technical Information Service, Springfield, VA (USA). Jun 1990. 64p. Available from NTISPC N01/MF N01.

Supersedes PB–89-859896.

This bibliography contains citations concerning heat-, wear-, and corrosion-resistant ceramic materials and their uses in automobile engines. Fabrication techniques for ignition system components, combustion chamber parts, gas-path seals, turbine rotors, stators, nozzles, blades, and heat exchangers are discussed. Ceramic metal composites suitable for automotive gas turbine engine components are also considered. (This updated bibliography contains 111 citations, 11 of which are new entries to the previous edition.)

40950 (PB–90-871450/XAB) **Ceramic engine components. January 1971-May 1990 (A Bibliography from the US Patent**

data base). Report for January 1971-May 1990. National Technical Information Service, Springfield, VA (USA). Jun 1990. 169p. Available from NTISPC N01/MF N01.

Supersedes PB–89-873145.

This bibliography contains citations of selected patents concerning ceramic materials that are resistant to heat, wear, and corrosion processes, and their use in internal combustion engines. Fabrication techniques of ignition system components, combustion chamber parts, exhaust valves, turbine rotors, stators, blades, and heat exchangers are discussed. Ceramic metal composites suitable for engine components are also considered. (This updated bibliography contains 365 citations, 42 of which are new entries to the previous edition.)

40951 (UCRL-JC–103593) **Modeling of knock in spark-ignition engines.** Westbrook, C.K.; Pitz, W.J. Lawrence Livermore National Lab., CA (USA). [1990]. 10p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract W-7405-ENG-48. (CONF-900978–1: COMODIA '90: international symposium on diagnostics and modeling of combustion in internal combustion engines, Kyoto (Japan), 3-5 Sep 1990). Order Number DE90010875. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The chemical kinetic modeling of end gas autoignition leading to knocking behavior in spark ignition engines is discussed. The demands placed upon kinetic models by the conditions of temperature and pressure are examined, and the construction of both highly detailed and of more global or reduce kinetic models is outlined. Methods for including the influences of such factors as fuel molecule size and molecular structure are described for both types of knock model. The results of both types of model analyses are presented, and the strengths and weaknesses of each are discussed. 21 refs., 3 figs., 2 tabs.

3302 External Combustion Engines

40952 (PB–90-870353/XAB) **Stirling engines. December 1976-April 1990 (A Bibliography from the COMPENDEX data base). Report for December 1976-April 1990.** National Technical Information Service, Springfield, VA (USA). May 1990. 115p. Available from NTISPC N01/MF N01.

Supersedes PB–84-861566.

This bibliography contains citations concerning Stirling engine technology. Design, development, performance testing, and applications are discussed. Use in power generation, artificial heart systems, solar powered applications, and ground and marine vehicles are presented. Engine component design and material testing results are discussed. (This updated bibliography contains 280 citations, 58 of which are new entries to the previous edition.)

3303 Electric-Powered Systems

Refer also to citation(s) 40842, 40844, 40890

40953 (CONF-890240–6) **Electric vehicle battery R&D in the context of a propulsion system.** Patil, P.G. (USDOE Assistant Secretary for Conservation and Renewable Energy, Washington, DC (USA). Office of Transportation Systems); Christianson, C.C.; Miller, J.F. Argonne National Lab., IL (USA). [1989]. 7p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract W-31109-ENG-38. From Society of Automotive Engineers international congress and exposition; Detroit, MI (USA); 27 Feb - 3 mar 1989. Order Number DE90013667. Available from NTIS, PC A02/MF A01 - OSTI.

A battery system for an electric vehicle should be designed and developed in concert with the other components of the propulsion system. Technology development efforts sponsored by the US Department of Energy are addressing all the constituent electric vehicle component technologies, including the battery subsystem technologies, from the perspective of the complete propulsion system. This approach is considered to be essential for three reasons. First, the ultimate viability of a given battery technology can only be assured in the context of a complete propulsion system. Second, many required battery subsystem technology advancements can only be addressed in concert with the other propulsion system components. Third, development and testing of battery subsystem technologies in conjunction with powertrain subsystem technology development is necessary in order to provide essential information to the battery developer and to the vehicle developer that can not be obtained when battery development is performed as a discrete activity. 7 refs., 6 figs.

3304 Hybrid Systems

Refer also to citation(s) 40953

3308 Alternative Fuels

40954 (AD-A–220272/9/XAB) **Production and coating of pure boron powders. Final report, 1 September 1989-28 February 1990.** Calcote, H.F.; Gill, R.J.; Berman, C.H.; Felder, W. AeroChem Research Labs., Princeton, NJ (USA). 30 Mar 1990. 59p. (AEROCHEM-TP–489). Available from NTIS, PC A04/MF A01.

Boron is an attractive fuel because of its potential energy release with oxygen and because of its lightweight. It is, however, difficult to incorporate into a fuel system because an oxide layer forms on the surface and suppresses combustion. A new synthesis process has been evaluated for the preparation of boron fuel particles coated with titanium. The titanium coating prevents oxide from forming and aids in the combustion. Pure boron particles are produced by reaction of sodium with boron trichloride, the products expanded through a supersonic nozzle, in which titanium tetrachloride is added to produce titanium. The titanium coats the boron particle. The coated particles are separated from the gaseous sodium chloride by a new type supersonic virtual impact collector. The process has been analyzed by computer modeling and an apparatus has been designed to test the concept and prepare coated boron fuel particles for evaluation.

40955 (PB–90-220559/XAB) **Analysis of the economic and environmental effects of compressed natural gas as a vehicle fuel. Volume 1. Passenger cars and light trucks. Special report.** Environmental Protection Agency, Ann Arbor, MI (USA). Emission Control Technology Div. Apr 1990. 58p. Available from NTIS, PC A04/MF A01.

In July 1989 the President submitted to Congress his Administration's proposals for revising the Clean Air Act. One major component of his plan is the Clean Alternative Fuels Program. The program would replace a portion of the motor vehicle fleet in certain cities with new vehicles that meet stringent air emission limits operating on clean burning fuels such as methanol, ethanol, Compressed natural gas, liquified petroleum gas, electricity, and reformulate gasoline. The report, released by EPA, is the second in a series of reports that will discuss the economic and environmental issues associated with each of these fuels.

40956 (PB–90-222522/XAB) **Analysis of the economic and environmental effects of ethanol as an automotive fuel. Special report.** Environmental Protection Agency, Ann Arbor, MI (USA). Office of Mobile Sources. Apr 1990. 146p. Available from NTIS, PC A07/MF A01.

Portions of this document are not fully legible.

In July 1989 the President submitted to Congress his Administration's proposals for revising the Clean Air Act. One major component of the plan is the Clean Alternative Fuels Program. The program would replace a portion of the motor vehicle fleet in certain cities with new vehicles that meet stringent air emission limits operating on clean burning fuels such as methanol, ethanol, compressed natural gas, liquified petroleum gas, electricity, and reformulate gasoline. The report, released by EPA, is the fourth in a series of reports that will discuss the economic and environmental issues associated with each of these fuels.

40957 (PB–90-871831/XAB) **Alcohol fuels. November 1987-May 1990 (A Bibliography from the COMPENDEX data base). Report for November 1987-May 1990.** National Technical Information Service, Springfield, VA (USA). Jun 1990. 75p. Available from NTISPC N01/MF N01.

Supersedes PB–89-861926. .

This bibliography contains citations concerning the synthesis and use of alcohol fuels. Topics include synthesis of alcohol fuels from

biomass, specific catalysts for alcohol production, engine performance tests using alcohol fuels, and descriptions of various fuel blends. Catalysts for gasoline production from alcohols as starting materials are also considered. Some attention is given to economic aspects of production and future markets. (This updated bibliography contains 143 citations, 53 of which are new entries to the previous edition.)

40958 Lessons of Sunraycer. Wilson, H.G.; MacCready, P.B.; Kyle, C.R. *Scientific American (USA)*, 260(3): 90-97 (Mar 1989).

Powered entirely by sunlight, the 400-pound automobile averaged 41 miles per hour to win the 1867-mile race across Australia on the solar equivalent of five gallons of gas. The paper describes the integrated design and novel technology that could find application in practical electric cars. Innovations include the lightweight Magnequench brushless motor; braking by operating the motor as a generator and recycling about half the energy through the battery instead of dissipating it as heat in brake discs; and reduction of drag through streamlining its design. The paper describes engineering efforts to apply this technology to electric battery powered vans.

40959 The case for methanol. Gray, C.L. Jr.; Alson, J.A. *Scientific American (USA)*, 261(5): 108-114 (Nov 1989).

Spurred by concerns of declining air quality, the race for alternative automobile fuels is on. The authors advocate a switch to methanol, arguing that it is the most economic and environmentally prudent of the fuels now being considered. The authors conclude that the US should respond by developing a methanol-based transportation system as soon as possible. The paper compares the design and emissions of a gasoline-powered vehicle to a methanol-powered vehicle, highlighting the foreseeable benefits and identifying anticipated problems with methanol fuels.

35 ARMS CONTROL

Refer also to citation(s) 41521, 42266

40960 (AD-A–219844/8/XAB) **Tactical nuclear weapons responsibility: Ordnance versus field artillery. Study project.** Fields, J.A. Army War Coll., Carlisle Barracks, PA (USA). 8 Mar 1990. 36p. Available from NTIS, PC A03/MF A01.

There has existed and still exists an operational dichotomy in the area of the provision of tactical nuclear weapons to United States Army forces versus those allied forces in a combined theater of operations. Specifically, within the NATO environment and to a very small degree within Combined Forces Korea, there exists a condition where tactical nuclear weapons are supplied to the U.S. firing unit by an organization under the proponency of the Ordnance Corps. On the other hand, within the same theater, the non-U.S. force receives their tactical nuclear weapons by an organization under the proponency of the Field Artillery. This paper will examine the functions performed by this duplication of supply organizations and briefly list the supporting structure. It will then explore any possible purpose for the duplication which would justify this apparent mission replication. Discussion will then follow which will list the pros and cons of staying with the status quo or the possible assignment of the supply function to a single branch proponency. Conclusions are then drawn and recommendations made for improving the current system of tactical nuclear weapon support.

40961 (AD-A–220311/5/XAB) **Unfavorable situation: NATO and the conventional balance.** Thomson, J.A. Rand Corp., Santa Monica, CA (USA). Nov 1988. 44p. (RAND/N–2842-FF/RC). Available from NTIS, PC A03/MF A01.

The view, long and widely held, that NATO conventional military forces are inferior to Warsaw Pact forces is one of the most important factors shaping postwar history. It influenced the size and nature of the American military commitment to Europe. It is at the heart of the extended deterrence strategy, in which the U.S. commitment to use nuclear weapons in the defense of Europe offsets the Warsaw Pact's perceived conventional superiority. The notion of Western inferiority runs through much of today's public debate on security policy-the INF Treaty, the future of nuclear and conventional arms control, U.S. and Allied defense programs, the burden-sharing debate, and so forth. The debates have spawned a new round of discussions on the nature of the conventional military balance in Europe and will affect U.S. and Western policies. The term balance conjures up the image of a scale, with the Warsaw Pacts military power placed on one side and NATO's on the other. This reflects the normal bean count approach to the military balance: Total number of tanks, artillery, combat aircraft, etc. is the surrogate for military power. The image of the scale conveys a deeper meaning, however: If the Warsaw Pact were military superior or the balance were unfavorable to NATO, NATO would, by implication, lose a military conflict in Central Europe fought with purely conventional weapons. The perception is the one that has shaped the broader Western policy debate.

40962 (AD-A–220492/3/XAB) **Implications of cloud obscuration on ground-based laser systems for strategic defense. Technical report.** Tavis, M.T.; Levinson, S.W.; Parker, K.M. Aerospace Corp., El Segundo, CA (USA). 12 Mar 1990. 26p. (TR–0090(5017-03)-1). Available from NTIS, PC A03/MF A01.

The evolution and the current status of the Strategic Defense System Phase II Ground-Based Laser (GBL) System Concept is reviewed in this report. In particular, the impact of clouds on system configuration and site selection is discussed. By using current models of correlated probabilities of cloud-free line of sight and cloud-free arc (CFLOS4D and CFARC) for several ground stations with cloud realizations provided by the Boehm Saw Tooth generator, we have determined the number of ground sites required to achieve various levels of desired system weather availability. We briefly describe potential improvements in the models and discuss the necessity for using the Whole Sky Imager results now being generated to validate these models with empirical data, thereby lending further credibility to GBL System Concepts.

40963 (AD-A–220598/7/XAB) **Terrorists and the potential use of biological weapons: A discussion of possibilities. Interim report.** Simon, J. Rand Corp., Santa Monica, CA (USA). Dec 1989. 33p. (RAND/R–3771-AFMIC). Available from NTIS, PC A03/MF A01.

This report considers the potential for terrorists to use biological weapons. It discusses the implications of recent trends in terrorism for the future use of biological agents and the reasons terrorists might be motivated to use them. It then identifies several constraints that inhibit terrorists from venturing into this new type of conflict and the factors that could break down these constraints. Finally, it establishes some broad characteristics that could identify the types of terrorist groups that might be more likely than others to use biological weapons. The findings suggest that, since the technological, logistical, and financial barriers to the use of biological agents are not insurmountable, a key determinant in the potential use of such agents will be the willingness of terrorists to engage in this new type of violence. Therefore, efforts to improve intelligence regarding terrorist group strategies and capabilities will become increasingly critical in the future.

40964 (PB–90-206459/XAB) **President's Strategic Defense Initiative.** Executive Office of the President, Washington, DC (USA). Jan 1985. 16p. Available from NTIS, PC A03/MF A01.

The President announced his Strategic Defense Initiative (SDI) in his March 23, 1983, address to the nation. Its purpose is to identify ways to exploit recent advances in ballistic missile defense technologies that have potential for strengthening deterrence–and thereby increasing the security and that of the allies. The program is designed to answer a number of fundamental scientific and engineering questions that must be addressed before the promise of these new technologies can be fully assessed. The SDI research program will provide to a future President and a future Congress the technical knowledge necessary to support a decision in the early 1990's on whether to develop and deploy such advanced defensive systems.

40965 (PB–90-869793/XAB) **Arms control. November 1981-February 1986 (A Bibliography from the NTIS data base). Report for November 1981-February 1986.** National Technical Information Service, Springfield, VA (USA). May 1990. 113p. Available from NTISPC N01/MF N01.

See also PB–90-869801.

This bibliography contains citations concerning policies, global relations, and agreements pertaining to arms control. Strategic Arms Limitation Talks (SALT), security affairs, proliferation due to commercial uses of nuclear energy, and deterrence and disarmament are among the topics discussed. The military uses of space, and the control and distribution of chemical warfare agents are also considered. (This updated bibliography contains 121 citations, none of which are new entries to the previous edition.)

40966 (PB–90-869801/XAB) **Arms control. March 1986-April 1990 (A Bibliography from the NTIS data base). Report for March 1986-April 1990.** National Technical Information Service, Springfield, VA (USA). May 1990. 160p. Available from NTISPC N01/MF N01.

Supersedes PB–86-857356. See also PB–90-869793.

This bibliography contains citations concerning policies, global relations, and agreements pertaining to arms control. Strategic Arms Limitation Talks (SALT), security affairs, proliferation due to commercial uses of nuclear energy, and deterrence and disarmament are among the topics discussed. The military uses of space, and the control and distribution of chemical warfare agents are also considered. (This updated bibliography contains 322 citations, all of which are new entries to the previous edition.)

3501 Policy, Negotiations, and Legislation

Refer also to citation(s) 40470

40967 Getting out of the STARTing block. Graybeal, S.N.; McFate, P.B. *Scientific American (USA),* 261(6): 61-67 (Dec 1989).

Worries about verification should not be putting the brakes on START, the Strategic Arms Reduction Talks. The best way to reach an beneficial agreement is to pursue negotiations on arms reduction and on verification together. The key, according to the authors, is to try to match the arms-reduction requirements of a treaty with the ability to detect and deter militarily significant violations. This paper enlarges on these opinions.

40968 Testing weapons in space. Carter, A.B. *Scientific American (USA),* 261(1): 33-40 (Jul 1989).

The Antiballistic-Missile Treaty seems to forbid the testing of ABM weapons in space, but the US has pushed for a broad interpretation of the language. Would a more permissive regime really serve US interests? This paper reviews the rationale of the treaty's provisions to help answer this question. Four modes of testing a space weapon are treated differently by the ABM treaty: (1) an orbiting weapon intercepts a ballistic weapon is flight; (2) intercepting weapon is launched on a suborbital flight; (3) both weapon and target are placed in space; and (4) orbiting weapon is aimed at an aircraft in flight or a target on the ground. Three approaches to negotiating an agreement to limit testing weapons in space are discussed. They differ in the strictness of the limits.

3503 Verification

Refer also to citation(s) 40967

40969 (CONF-9007106–20) **Tagging and fissile material verification concepts for nuclear warhead dismantlement.** DeVolpi, A. Argonne National Lab., IL (USA). [1990]. 6p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-31109-ENG-38. From Institute of nuclear materials management conference; Los Angeles, CA (USA); 15-18 Jul 1990. Order Number DE90013653. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Arms control treaties that reduce the number of deployable nuclear-warhead delivery systems might also lead to provisions for the verified dismantlement of nuclear weapons. Based on public information and very simple conceptual models of nuclear warheads, one can visualize a set of procedural and technological requirements to account for warheads removed from deployed sites and ultimately dismantled. To accomplish the accounting function, verification-quality tags and/or seals might be needed in order that the warheads taken out of storage can be tracked to the dismantlement site. These tags/seals would represent an overlay on the existing chain of custody. The verified dismantlement of the warheads poses special problems in confirming their identity and in avoiding the loss of sensitive information. A central factor is the publicly recognized need for some minimum quantity of fissile material to constitute a nuclear warhead. A measurement system that could make such a determination without giving away unnecessary information would be desired. Some approaches based on existing fissile assay methods are discussed. 1 ref., 2 figs.

40970 (SAND–90-0572) **Equipment for potential unattended use in treaty verification applications.** Drayer, D.D. (ed.). Sandia National Labs., Albuquerque, NM (USA). May 1990. 25p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC04-76DP00789. Order Number DE90013610. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Containment and Surveillance (C/S) equipment, which is used in international safeguards applications, is normally expected to operate unattended within a facility in a host country for extended periods of time. To ensure that this equipment consistently provides high-quality data, the equipment used to ensure the data's integrity must be highly reliable and tamper-resistant. Although designed specifically for use by the International Atomic Energy Agency to comply with the Non-Proliferation Treaty, the equipment has potential applications for both bilateral and multilateral verification schemes for other treaties. This report describes C/S equipment that has been developed by Sandia National Laboratories, and discusses its potential applications. This equipment includes surveillance equipment, seals, monitoring equipment, and authentication equipment. 16 refs., 20 figs.

36 MATERIALS

3601 Metals and Alloys

Refer also to citation(s) 40274, 40396, 40434, 40615, 40619, 40620, 40621, 40698, 40737, 40769, 40813, 41076, 41078, 41131, 41149, 41152, 41154, 41159, 41163, 41168, 41174, 41184, 41191, 41212, 41213, 41225, 41227, 41246, 41277, 41295, 41323, 41507

40971 (AD-A–220241/4/XAB) **Damping associated with incipient melting in aluminum-indium alloys. Research and development report, October 1987-February 1989.** Wong, C.R.; Diehm, O.; Van Aken, D.C. David W. Taylor Naval Ship Research and Development Center, Annapolis, MD (USA). Ship Materials Engineering Dept. Jan 1990. 19p. (DTRC/SME–89/95). Available from NTIS, PC A03/MF A01.

The strain amplitude dependent damping of binary aluminum-indium alloys containing nominally 0.6 to 17.3 weight percent indium was studied. A dynamic mechanical analyzer was used to measure the damping capacity of these materials. Pure aluminum (99.99%) exhibited strain dependent damping at strain values as low as 70 microstrain. The addition of 0.6 weight percent indium reduced the strain dependent damping by a factor of 2, but the strain dependent damping was equivalent to that of pure aluminum. Binary aluminum-indium alloys containing 4, 8, 12 and 16 weight percent indium exhibited a general increase in loss factor with increasing indium content; however, the strain dependent damping was no greater than that of the pure aluminum sample. No significant increase in damping was observed when the binary alloys were tested at temperatures above the melting point of indium. Two damping peaks were observed near the eutectic melting point when tested at 10 Hz and differential scanning calorimetry verified both of these as due to the melting of the indium inclusions. It was concluded that the higher temperature damping peak was associated with smaller indium inclusions and that the damping peaks were related to the solute segregation associated with the binary eutectic reaction.

40972 (AD-A–220424/6/XAB) **$Sm_2(Co,Fe,Cu,Zr)17$ magnets with higher Fe content.** Liu, S.; Ray, A.E. Dayton Univ., OH (USA). School of Engineering. Sep 1989. 5p. Available from NTIS, PC A01/MF A01.

Pub. in IEEE Transactions on Magnetics, Vol. 25, No. 5, 3785-3787(Sep 1989).

Successful attempts were made to improve the magnetic properties of Samarium 2,(Cobalt, iron, copper, zirconium)17 magnets by

increasing the iron content without raising the zirconium content. With increasing Fe content, the remanence rises monotonically while the intrinsic coercive force drops sharply for $0.27 < v < 0.29$ and then increases for $.30 < v < .33$ in Sm(Co(bal)Fe(v)Cu(.056)Zr(.02)7.546).

40973 (BARC–1500 B2.1-B2.3) **Deuteration of machined titanium targets for cold fusion experiments (Paper No. B2).** Shrikhande, V.K. (Bhabha Atomic Research Centre, Bombay (India). Technical Physics and Prototype Engineering Div.); Mittal, K.C. Bhabha Atomic Research Centre, Bombay (India). Dec 1989. In *BARC studies in cold fusion (April-September 1989).* Order Number DE90632005. Available from NTIS (US Sales Only), PC A07/MF A01; OSTI; INIS.

The rate of absorption of deuterium gas by titanium increased with temperature if the surface of titanium is clean. The rate is reduced if surface is contaminated with oxygen. Taking these facts into account, procedure evolved to prepare titanium targets for cold fusion experiments is described. Titanium targets of different sizes and shapes were machined out of titanium rod avoiding overheating. Each piece was a fraction of a gram in mass. These machined targets were degreased ultrasonically in trichloroethylene and the oxide layer, if any, on the surface was removed by acid treatment. The chemically cleaned targets were degassed by heating them to ≈= 900 degC in glass vacuum chamber using an induction heater. They were passed through three cycles of H_2 absorption/desorption to create active sites for deuterium absorption. The targets were heated to ≈ 600degC in deuterium atmosphere under pressure and allowed to cool. Three cycles of D_2 absorption/desorption were given. D/Ti ratio was found to be ≈ 10^{-3}. If it is assumed that the absorption is restricted to the surface, this ratio is likely to be higher. (M.G.B.). 6 refs., 1 tab.

40974 (CEA-CONF–9998) **Effect of compressive stress field during dwell time in creep fatigue evaluation.** Autrusson, B. CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Dept. d'Etudes Mecaniques et Thermiques. 1989. 5p. (CONF-890855–: 10. international conference on Structural Mechanics in Reactor Technology (SMIRT), Anaheim, CA (USA), 14-18 Aug 1989). Order Number DE90508401. Available from NTIS (US Sales Only), PC A02/MF A01.

In this survey, we present a comparison of multiaxial stress effects in creep fatigue damage. The open literature proposes ten equivalent stress criteria which can be tested with experimental creep and creep-fatigue results.

40975 (CEA-CONF–10013) **Experimental and numerical thermal buckling studies on cylinders.** Brochard, J.; Combescure, A.; Locatelli, T.; Tomassian, R. CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Dept. d'Etudes Mecaniques et Thermiques. 1989. 9p. (CONF-890855–: 10. international conference on Structural Mechanics in Reactor Technology (SMIRT), Anaheim, CA (USA), 14-18 Aug 1989). Order Number DE90508408. Available from NTIS (US Sales Only), PC A02/MF A01.

An important program of buckling experiments is carried out by C.E.A./D.E.M.T on thin cylinders subjected to a very strong axial gradient of temperature, an axial tension stress, and an external pressure, in order to evaluate: - damage due to thermal buckling, - influence of a thermal load on reduction of buckling pressure, - progressive buckling under a cyclic thermal load.

40976 (CONF-900466–72) **The epitaxial growth of copper on the (111) surface of silicon.** Walker, F.J. (Oak Ridge National Lab., TN (USA)); McKee, R.A.; Conner, J.R. Oak Ridge National Lab., TN (USA). [1990]. 9p. Sponsored by U.S. Department of Defense; U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Contract AFOSR-ISSA-89-0015. From Spring meeting of the Materials Research Society; San Francisco, CA (USA); 16-21 Apr 1990. Order Number DE90013817. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The progression of the epitaxy of Cu(111) on Si(111) has been studied using surface sensitive techniques and the as-grown film studied using high resolution transmission electron microscopy (HRTEM). A molecular beam epitaxy (MBE) system has been used to deposit films on 3-inch-diameter silicon substrates. Across this large area a graded thickness of 0 to 10 nm of copper was deposited and scanned using Auger electron spectroscopy (AES) and low energy electron diffraction (LEED). For films grown at 373 K, silicon alloys with the copper up to a thickness of 2.5 nm, consistent with previous studies. LEED indicates an ordered R30°-$\sqrt{3}$ x $\sqrt{3}$ Cu(111) surface which results from the alloying of copper and silicon. HRTEM images from the interface region show the alloy to be 2.0 nm thick, crystalline, and epitaxial to the Si(111) surface. There are indications that the interface alloy may be a metastable copper silicide. This alloy is important in the mechanism for the growth of Cu(111) on Si(111). 13 refs., 3 figs.

40977 (CPIA-PUBL–515-VOL-1, pp. 135-162) **Probability of failure and risk assessment of propulsion structural components.** Shiao, M.C. (Sverdrup Technology, Inc., Cleveland, OH (USA)); Chamis, C.C. Johns Hopkins Univ., Baltimore, MD (USA). May 1989. (CONF-8905134–: JANNAF propulsion meeting, Cleveland, OH (USA), 22-25 May 1989). In *The 1989 JANNAF Propulsion Meeting, volume 1.* Available from NTIS, PC A25/MF A04.

Due to increasing need to account for the uncertainties in material properties, loading conditions, or geometries, a methodology was developed to determine structural reliability and the assess the risk associated with it. The methodology consists of a probabilistic structural analysis by a probabilistic finite element computer code Nonlinear Evaluation of Stochastic Structures Under Stress (NESSUS) and a generic probabilistic material properties model. The methodology is versatile and is equally applicable to high and cryogenic temperature structures. Results obtained demonstrate that the whole issue of structural reliability and risk can be formally evaluated using the methodology developed which is inclusive of uncertainties in material properties, structural parameters and loading conditions. The methodology is described in some detail with illustrative examples.

40978 (CPIA-PUBL–515-VOL-1, pp. 349-366) **Arcjet cathode phenomena.** Curran, F.M. (Air Force Academy, CO (USA)); Haag, T.W.; Raquet, J.F. Johns Hopkins Univ., Baltimore, MD (USA). May 1989. (CONF-8905134–: JANNAF propulsion meeting, Cleveland, OH (USA), 22-25 May 1989). In *The 1989 JANNAF Propulsion Meeting, volume 1.* Available from NTIS, PC A25/MF A04.

Cathode tips made from a number of different materials were tested in a modular arcjet thruster in order to examine cathode phenomena. Periodic disassembly and examination, along with the data collected during testing, indicated that all of the tungsten-based materials behaved similarly despite the fact that in one of these samples the percentage of thorium oxide was doubled and another was 25 percent rhenium. The mass loss rate from a 2 percent thoriated rhenium cathode was found to be an order of magnitude greater than that observed using 2 percent thoriated tungsten. Detailed analysis of one of these cathode tips showed that the molten crater contained pure tungsten to a depth of about 150 microns. Problems with thermal stress cracking were encountered in the testing of a hafnium carbide tip. Post test analysis showed that the active area of the tip had chemically reacted with the propellant. A 100 hour continuous test was run at about 1 kW. Post test analysis revealed no dendrite formation, such as observed in a 30 kW arcjet lifetest, near the cathode crater. The cathodes from both this test and a previously run 1000 hour cycled test displayed nearly identical arc craters. Data and calculations indicate that the mass losses observed in testing can be explained by evaporation.

40979 (DOE/ER/45142–10) **Very low temperature studies of hyperfine effects in metals: Final report, August 1, 1984–December 31, 1988.** Weyhmann, W. Minnesota Univ., Minneapolis, MN (USA). School of Physics and Astronomy. Mar 1989. 13p. Sponsored by U.S. DOE Energy Research. DOE Contract FG02-84ER45142. Order Number DE90013960. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

During the grant period reported here we have almost completed our proposed work on polycrystalline $PrCu_6$, having measured the susceptibility and placed a limit on the magnitude of the magnetostriction. At present we are completing final measurements of the magnetization. This work was done on cylindrical rods of the compound to avoid demagnetization effects and data was taken over a

wide range of temperatures including the Curie temperature. Including work done under a previous Department of Energy grant, we now have a rather complete experimental picture of the behavior of $PrCu_6$ at the nuclear magnetic ordering transition. In the course of this work we have also investigated techniques of measurement and cooling which may be of use to other investigators, e.g., a simple method of avoiding distortion of the magnetization signal at a phase transition when using superconducting flux transformers. 8 refs.

40980 (EPRI-ER–6887) **Improved superclean NiCrMoV rotor steel: Final report.** Bodnar, R.L. (Bethlehem Steel Corp., PA (USA). Homer Research Lab.); Hansen, S.S.; Michael, J.R.; Steigerwalt, R.E. Electric Power Research Inst., Palo Alto, CA (USA); Bethlehem Steel Corp., PA (USA). Homer Research Lab. ©Jul 1990. 121p. Sponsored by Electric Power Research Institute. Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

Due to its excellent creep rupture properties and relative economy, silicon-deoxidized, tempered bainitic 1%CrMoV steel is currently used extensively for high-temperature steam turbine rotor forgings operating at temperatures up to 565°C. However, there is considerable impetus to improve the toughness of this steel while maintaining its current level of creep rupture strength and vice versa. The toughness of 1%CrMoV steel is improved by lowering the bainite start (B_s) temperature in a 'superclean' base composition which is essentially free of Mn, Si, P, S, Sb, As and Sn. The B_s temperature can be lowered through the addition of alloying elements (i.e. C, Ni, Cr and Mo). Through suitable alloy additions, the 50% FATT of this grade was lowered from approximately 100°C to below room temperature. This improved toughness provides the opportunity to eliminate the special precautionary procedures currently used in the startup and shutdown of steam turbines. In general, the creep rupture strengths of these new 'superclean' steels equal or exceed that of the standard 1%CrMoV steel. In addition, the 'superclean' steels have not been found to be susceptible to temper embrittlement, and have similar room temperature fatigue crack propagation characteristics and elevated tensile properties to the standard 1%CrMoV steel. The most promising steels in terms of a balance between creep rupture and toughness properties contain 2.5% Ni and 0.03%/0.04% Nb (for austenite grain refinement and enhanced tempering resistance), i.e. 2.5NiCrMoVNb steel. These new steels may also find application in combination high-temperature – low-temperature rotors and gas turbine rotors. 106 refs., 34 figs., 10 tabs.

40981 (EPRI-GS–6907) **Superclean steel development: Stress corrosion cracking characteristics: Final report.** Electric Power Research Inst., Palo Alto, CA (USA); Asea Brown Boveri Ltd., Baden (Switzerland). Materials Technology Dept. ©Jul 1990. 19p. Sponsored by Electric Power Research Institute. Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

Stress corrosion tests (SCC initiation and propagation) were carried out on a high purity version of the 3.5% NiCrMoV low pressure rotor steel in comparison to similar steels of conventional cleanness. In the constant load tests in 30% sodium hydroxide solution the clean steel showed longer times to crack initiation than the conventional steels with comparable strength levels. The amount of scatter makes it difficult to quantify the improvement, which lay at or above 5% in stress level. Neither in pure water (aerated and deaerated) nor in a concentrated caustic solution were differences in the stress corrosion crack velocities detected. Neither the clean steel nor the conventional steel tested in this programme showed any increase in SCC susceptibility after aging at 350 or 450°C for 10,000 hours. 19 refs., 17 figs., 3 tabs.

40982 (FTINT–18-88) **Friction-and-wear characteristics of materials used in dry friction units designed for low-temperature applications: Tables of recommended reference data.** Gamulya, G.D.; Guslyakov, A.A.; Kopteva, T.A. AN Ukrainskoj SSR, Kharkov (Ukrainian SSR). Fiziko-Tekhnicheskij Inst. Nizkikh Temperatur. 1988. 33p. (In Russian). Order Number DE90633322. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Friction-and-wear characteristics have been tabulated for a widi range of structural materials (metals, alloys, polymers, composites, solid lubricant coatings etc.), which are used in dry friction units designed for low-temperature application. The temperature interval of 4,2-293 K has been chosen for analyzing the effect of load, contact geometry, pressure and environment on the friction coefficient, wear rate and life of various combinations of materials in model friction units. 8 refs.; 5 figs.; 29 tabs.

40983 (GKSS–89/E/43) **Hysteresis effect in crack propagation in the threshold range of very strong steel 21 CrMoNiV 57.** Vaidya, W.V. (GKSS-Forschungszentrum Geesthacht GmbH, Geesthacht-Tesperhude (Germany, F.R.). Inst. fuer Werkstofforschung). GKSS-Forschungszentrum Geesthacht GmbH, Geesthacht-Tesperhude (Germany, F.R.). 1989. 13p. (In German). (CONF-8902168–: 21. lecture meeting of the DVM Study Group on francture mechanisms: fracture-mechanical characteristics for structural components evaluation, Bad Nauheim (Germany, F.R.), 27-28 Feb 1989). Available from GKSS-Forschungszentrum Geesthacht GmbH, Geesthacht-Tesperhude (Germany, F.R.).

The very strong steel 21 CrMoNiV 57 showed the following crack propagation behaviour in the threshold range: - The threshold value decreased with increasing R value as expected. - Regardless of the R ratio and the threshold value reached, the hysteresis effect was found during subsequent increase in load, even if there was no crack closing ($R=0.7=R_{eff}$). - The ΔK range in which the crack could not spread, lay 25% to 38% above the threshold value reached. - According to metallurgical investigations, the cause of the hysteresis effect lay in the fact that the crack stops at microstructural obstacles. This also leads to relaxation of the ΔK and ΔK_{eff} concept. (orig.).

40984 (GKSS–89/E/58) **Microanalysis of inclusion/matrix interfaces in weld metals.** Es-Souni, M. (GKSS-Forschungszentrum Geesthacht GmbH, Geesthacht-Tesperhude (Germany, F.R.). Inst. fuer Werkstofforschung); Beaven, P.A. GKSS-Forschungszentrum Geesthacht GmbH, Geesthacht-Tesperhude (Germany, F.R.). 1989. 16p. (CONF-891029–: ECASIA 89: European conference on applications of surface and interface analysis, Juan-les-Pins (France), 23-27 Oct 1989). Order Number DE90510602. Available from NTIS (US Sales Only), PC A03/MF A01.

The effects of non-metallic inclusions on the microstructure of as deposited C-Mn weld metals have been investigated in a series of welds produced using different electrode coatings to obtain inclusions of different chemical compositions. The inclusions were analysed on carbon extraction replicas or in thin foils in a 120 kV TEM (STEM) system equipped with EDX facilities. Both X-ray microanalysis and convergent beam diffraction techniques with probe sizes down to 10 nm were used to characterize the inclusions and the inclusion/matrix interfaces. It was found that the 'cores' of the inclusions were mainly oxides such as $MnSiO_3$ or $MnAl_2O_4$. The surfaces of the inclusions were either coated with thin layers of copper sulfide, or mixtures of copper sulfide and titanium carbonitride when both copper and titanium were present as impurities in the welds. Effects of non-metallic inclusions on weld metal microstructure are discussed with respect to the above mentioned coatings and the heterogeneous nucleation of the fine acicular ferrite microconstituent. (orig.) With 4 figs., 1 tab.

40985 (GKSS–89/E/61) **Parameter study of temperature distribution in a work-piece during dry hyperbaric GTA-welding.** Fulfs, H. (GKSS-Forschungszentrum Geesthacht GmbH, Geesthacht-Tesperhude (Germany, F.R.). Inst. fuer Anlagentechnik). GKSS-Forschungszentrum Geesthacht GmbH, Geesthacht-Tesperhude (Germany, F.R.). 1989. 52p. (In German). Order Number DE90510601. Available from NTIS (US Sales Only), PC A04/MF A01.

In a sensitivity study the influence of initial and boundary welding parameters upon the spatial and temporal temperature distribution in a work-piece during dry hyperbaric GTA-welding is investigated. It will be shown that at constant arc current a variation of pressure (1-60 bar), arc length (3-10 mm), welding speed (1-2.5 mm/s) or the initial temperature (20-200deg C) of the work-piece to some extend significantly influences the size of melt and heat affected zone as well as the maximum temperature and cooling behaviour of the work-piece; compared to this no mentionable effects of shielding gas temperature (20-300deg C) or flow rate (10-500

dm_N^3/min) on the thermal condition of the work-piece can be recognized. The discovered relationships have been approximated by simple correlations, which can be used for parameter optimization and process control. (orig.) With 33 figs., 4 tabs.

40986 (IC–90/43) **Thermodynamics and structure of liquid metals from the charged-hard-sphere reference fluid.** Akinlade, O.; Lai, S.K.; Tosi, M.P. International Centre for Theoretical Physics, Trieste (Italy). Mar 1990. 28p. Order Number DE90633348. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Perturbative variational calculations of thermodynamic and structural properties of liquid metals, based on the use of ab initio and highly reliable nonlocal pseudopotentials for the electron-ion interactions and of the fluid of charged hard spheres as reference system, have recently been reported for the liquid alkalis from Na to Cs near freezing. We extend in this work the above calculations in two directions. Firstly, we discuss the predicted temperature dependence of the liquid structure factor for the same alkali metals over a limited temperature range above freezing. Secondly, we examine the usefulness of the approach for metals with relatively strong electron-ion interactions, namely Li and several polyvalent metals (Mg, Cd, Al, In, Tl and Pb). The charged-hard-sphere reference system leads to lower values of the Helmholtz free energy and to slightly improved values of the excess entropy for all the liquid metals that we evaluate, even though the polyvalent ones overall appear to be relatively close to fluids of neutral hard spheres. For the liquid alkalis at elevated temperatures, the calculated structure factors are of similar quality as in our previous work, that is, they show a systematic shift in the positions of peaks and valleys to slightly larger wave numbers and peak heights that are somewhat underestimated with increasing temperature. However, for liquid polyvalent metals, our approach yields quite good agreement with experiment for the positions of maxima and minima in the liquid structure factor, while it tends to somewhat overemphasize these structures. (author). 41 refs, 7 figs, 3 tabs.

40987 (KFK–4704) **Investigations of the corrosion behaviour of the Si-containing stainless steel 1.4361 with combined surface analysis, electrochemistry and radionuclide technique.** Maar-Stumm, M. Kernforschungszentrum Karlsruhe GmbH (Germany, F.R.). Inst. fuer Radiochemie; Kernforschungszentrum Karlsruhe GmbH (Germany, F.R.). Projekt Wiederaufarbeitung und Abfallbehandlung; Karlsruhe Univ. (T.H.) (Germany, F.R.). Fakultaet fuer Chemie. Mar 1990. 148p. (In German). (PWA–3/90). Order Number DE90510282. Available from NTIS (US Sales Only), PC A07/MF A01.

The present work aimed at detailed information on the corrosion behaviour and particularly the corrosion mechanism of the steel 1.4361 in concentrated nitric acid by use of a combination of electrochemical methods, radionuclide technique and surface analysis. For comparison steel samples corroded by other methods were investigated by surface analysis, too. At the beginning of the corrosion in nitric acid Fe and Ni are dissolved preferentially. Cr and Si are enriched in the surface region. A primary corrosion layer is formed which is equivalent to the oxidic overlayer of atmospherically oxidized samples. It consists of the oxides of chromium and iron mixed up with glass-like SiO_2. Ni does not contribute to the formation of the oxidic overlayer. On top of this primary corrosion layer there is an isolating gel-like SiO_2-layer with a thickness depending on strength and duration of the corrosive attack. Its mechanical stability decreases with increasing layer thickness. At the boundary to the primary corrosion layer this gel-like SiO_2-layer is closed, mechanically stable and conducting. Samples corroded under the standardized conditions of the Huey-test show a similar structure of the overlayer with the exception that the primary corrosion layer consists only of glass-like SiO_2. The combination of several methods revealed detailed information about mass loss and structure of the overlayer at different electrode potentials. (orig./MM).

40988 (LA-UR–90-827) **Power beam technology at Los Alamos/A review of research and development activities.** Casey, H. Los Alamos National Lab., NM (USA). [1990]. 11p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-36. (CONF-900955–1: 2. international conference on power beam technology: laser and electronic beam conference, Stratford-upon-Avon (UK), 23-26 Sep 1990). Order Number DE90009002. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This document discusses techniques and research programs in power beam welding at Los Alamos National Laboratories. Specific areas discussed are in plasma welding, electron beam welding and laser welding. 11 refs., 9 figs. (FSD)

40989 (LBL–28968) **Weldment mechanical properties of aluminum-copper-lithium alloy, 2090, at ambient and cryogenic temperatures.** Sunwoo, A.J. Lawrence Berkeley Lab., CA (USA). May 1990. 84p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00098. Order Number DE90014178. Available from NTIS, PC A05/MF A01 - OSTI; GPO Dep.

Weldment mechanical properties of Al–Cu–Li alloy, 2090, at ambient and cryogeinc temperatures have been investigated. The primary objective of this work is to develop a mechanistic understanding of the weldment mechanical properties with specific emphasis on their relation to the fusion zone and heat affected zone microstructures. In the fusion zone, prior thermomechanical processing of the base metal is erased during welding. The as-welded and post-weld heat treated fusion zones lack the precipitates, size, volume fraction, and homogeneity of the base metal. The T_1 precipitates are found either in the vicinity of other intermetallics or at the boundaries. Low weldment elongation is caused by the formation of intermetallics and continous film on the boundaries. Even with alloy addition to the fusion zone, the strength mismatch continues to exist due to the difference in strengthening mechanism: solid solution strengthening in the fusion zone and precipitation strengthening in the base metal. The ultimate tensile strength of the as-welded weldments is only 50% of the base metal yield strength, and localized deformation occurs in the softer fusion zone. A weldment elongation increases substantially with increasing Cu content in the fusion zone at both test temperatures. Magnesium additions to the fusion zone change the dendrite morphology, affecting the distribution of Cu segregation at the boundaries. The Mg welds show higher yield strengths, but the Cu–Mg combination leads to embrittlement. The difference in properties of the heat affected zone and the base metal is primarily caused by the dissolution of strengthening phases. At 578 K, the strength degrades due to dissolution of δ' phase and at 773 K, dissolution of T_1 phase. At 648 K, the growth of the equilibrium phases occurs: T_1 at both the matrix and the subgrain boundaries, and T_2 at the grain boundaries.

40990 (LBL–28972) **The role of inhibitors during electrodeposition of thin metallic films.** Armstrong, M.J. (California Univ., Berkeley, CA (USA). Dept. of Chemical Engineering). Lawrence Berkeley Lab., CA (USA). May 1990. 195p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00098. Order Number DE90014177. Available from NTIS, PC A10/MF A01 - OSTI; GPO Dep.

The role of brightening agents during the deposition of thin metal films was analyzed. The model brightening system studied was copper deposition in the presence of benzotriazole (BTA). Emphasis was placed on the early stages of deposition. The development of microtopography was characterized with in situ scanning tunneling microscopy. Cuprous-BTA film formation was measured with impedance spectroscopy. Copper electrochemistry was measured with double-pulse potentiometry. The incorporation of BTA, including the effects of mass transport conditions, was studied with x-ray photoelectron spectroscopy and secondary ion mass spectroscopy. A visual survey of deposits from 0.5 M $CuSO_4$, 0.5 M H_2SO_4 indicated that brightening occurs when the concentration of BTA is greater than 100 μM and the current density is greater than 50 mA/cm^2. A passive layer was found to form during cathodic polarization of copper in 0.5 M $CuSO_4$, 0.5 M H_2SO_4 with 100 and 200 μM BTA. Following breakdown of the passive layer, with increased polarization, the copper remains covered with a BTA film with a coverage following Langmuir adsorption kinetics. Benzotriazole was not incorporated into the copper deposits. The nucleation site density of Cu on Pt was only a function of overpotential irrespective of the BTA concentration. The presence of BTA increases the overpotential (resulting in an increase in nucleation rate) for a given

current density which results in a decreased particle size. Benzotriazole altered the morphology of the deposited Cu. Deposits from BTA free electrolyte consisted of flat planes terminated with ledges with growth occurring at the ledges. Deposits from BTA containing electrolyte consisted of hemispheres with growth occurring uniformly on the surface.

40991 (N–90-20200) **Rolling contact fatigue of surface modified 440C using a 'Ge-Polymet' type disc rod test rig.** Thom, R.L. National Aeronautics and Space Administration, Huntsville, AL (USA). George C. Marshall Space Flight Center. Mar 1989. 23p. (NASA-TM–100390;NAS–1.15:100390). Available from NTIS, PC A03/MF A01.

Through hardened 440 C martensitic stainless steel test specimens were surface modified and tested for changes in rolling contact fatigue using a disc on rod test rig. The surface modifications consisted of nitrogen, boron, titanium, chromium, tantalum, carbon, or molybdenum ion implantation at various ion fluences and energies. Tests were also performed on specimens reactively sputtered with titanium nitride.

40992 (N–90-20431) **Model development in viscoplastic ratchetting.** Freed, A.D.; Walker, K.P. National Aeronautics and Space Administration, Cleveland, OH (USA). Lewis Research Center. Apr 1990. 32p. (NASA-TM–102509;E–5311;NAS–1.15:102509). Available from NTIS, PC A03/MF A01.

Space Station Freedom's solar dynamic power modules, like all power plants, contain components that are subjected to conditions which favor thermally driven ratchetting. Existing viscoplastic models tend to overpredict ratchetting behavior, because their back stress (the kinematic variable) seems to stick more than it should during unloading. For this reason, a study was undertaken to compare a variety of possible modifications to the evolution equation for back stress. All models considered herein have a hardening vs. dynamic-recovery format. To remove the stickiness of the back stress, a linear dependence on stress rate is introduced into the evolution equation for back stress in a variety of ways. Several favorable models were screened out of the field of candidates by qualitatively determining their relative ability to fit experimentally observed behavior through six numerical experiments. A final selection must be made by quantitatively correlating the proposed models with experimental data, and then seeing which candidate does the best job of predicting observed ratchetting behavior. This is a subject of future work.

40993 (N–90-20454, pp. 16) **Structural comparison of nickel electrodes and precursor phases.** Cornilsen, B.C.; Shan, Xiaoyin; Loyselle, P. National Aeronautics and Space Administration, Cleveland, OH (USA). Lewis Research Center. Dec 1989. (NASA-CP–3056;E–4708;NAS–1.55:3056;CONF-8904196–: 2. space electrochemical research and technology conference, Cleveland, OH (USA), 11-13 Apr 1989). In *Space electrochemical research and technology (SERT), 1989.* Available from NTIS, PC A16/MF A02.

Researchers summarize previous Raman spectroscopic results and discuss important structural differences in the various phases of active mass and active mass precursors. Raman spectra provide unique signatures for these phases, and allow one to distinguish each phase, even when the compound is amorphous to x rays (i.e., does not scatter x rays because of a lack of order and/or small particle size). The structural changes incurred during formation, charge and discharge, cobalt addition, and aging are discussed. The oxidation states and dopant contents are explained in terms of the nonstoichiometric structures.

40994 (N–90-21123) **Characterization of failure processes in tungsten copper composites under fatigue loading conditions.** Kim, Yongsuk; Verrilli, M.J.; Gabb, T.P. National Aeronautics and Space Administration, Cleveland, OH (USA). Lewis Research Center. 1989. 22p. (NASA-TM–102371;E–5090;NAS–1.15:102371;CONF-891135–: ISTFA '89: international symposium for testing and failure analysis, Los Angeles, CA (USA), 6-10 Nov 1989). Available from NTIS, PC A03/MF A01.

A fractographic and metallographic investigation was performed on specimens of a tungsten fiber reinforced copper matrix composite (9 vol percent), which had experienced fatigue failures at elevated temperatures. Major failure modes and possible failure mechanisms, with an emphasis placed on characterizing fatigue damage accumulation, were determined. Metallography of specimens fatigued under isothermal cyclic loading suggested that fatigue damage initiates in the matrix. Cracks nucleated within the copper matrix at grain boundaries, and they propagated through cavity coalescence. The growing cracks subsequently interacted with the reinforcing tungsten fibers, producing a localized ductile fiber failure. Examinations of interrupted tests before final failure confirmed the suggested fatigue damage processes.

40995 (N–90-21138) **High temperature fatigue behavior of tungsten copper composites.** Verrilli, M.J.; Kim, Yongsuk; Gabb, T.P. National Aeronautics and Space Administration, Cleveland, OH (USA). Lewis Research Center. Oct 1989. 18p. (NASA-TM–102404;E–5156;NAS–1.15:102404;CONF-8910240–: Fundamental relationships between microstructure and mechanical properties of metal matrix composites symposium, Indianapolis, IN (USA), 1-5 Oct 1989). Available from NTIS, PC A03/MF A01.

The high temperature fatigue behavior of a 9 vol percent, tungsten fiber reinforced copper matrix composite was investigated. Load-controlled isothermal fatigue experiments at 260 and 560 C and thermomechanical fatigue (TMF) experiments, both in phase and out of phase between 260 and 560 C, were performed. The stress-strain response displayed considerable inelasticity under all conditions. Also, strain ratcheting was observed during all the fatigue experiments. For the isothermal fatigue and in-phase TMF tests, the ratcheting was always in a tensile direction, continuing until failure. The ratcheting during the out-of-phase TMF test shifted from a tensile direction to a compressive direction. This behavior was thought to be associated with the observed bulging and the extensive cracking of the out-of-phase specimen. For all cases, the fatigue lives were found to be controlled by damage to the copper matrix. Grain boundary cavitation was the dominant damage mechanism of the matrix. On a stress basis, TMF loading reduced lives substantially, relative to isothermal cycling. In-phase cycling resulted in the shortest lives, and isothermal fatigue at 260 C, the longest.

40996 (N–90-21171) **Surface characterization of hydrogen charged and uncharged alpha-2 and gamma titanium aluminide alloys using AES and REELS.** Shanabarger, M.R. California Univ., Santa Barbara, CA (USA). 1990. 12p. (NASA-CR–186561;NAS–1.26:186561). Available from NTIS, PC A03/MF A01.

The surfaces of selected uncharged and hydrogen charged alpha-2 and gamma titanium aluminide alloys with Nb additions were characterized by Auger electron (AES) and reflected electron energy loss (REELS) spectroscopy. The alloy surfaces were cleaned before analysis at room temperature by ion sputtering. The low energy (500 eV) ion sputtering process preferentially sputtered the surface concentration. The surface concentrations were determined by comparing AES data from the alloys with corresponding data from elemental references. No differences were observed in the Ti or Nb Auger spectra for the uncharged and hydrogen charged alloys, even though the alpha-2 alloy had 33.4 atomic percent dissolved hydrogen. Also, no differences were observed in the AES spectra when hydrogen was adsorbed from the gas phase. Bulk plasmon energy shifts were observed in all alloys. The energy shifts were induced either by dissolved hydrogen (alpha-2 alloy) or hydrogen adsorbed from the gas phase (alpha-2 and gamma alloys). The adsorption induced plasmon energy shifts were greatest for the gamma alloy and cp-Ti metal.

40997 (ORNL/FTR–2777) **[Certification of welding and inspection personnel]: Foreign trip report, November 15–November 20, 1987.** Pepper, C.E. Oak Ridge National Lab., TN (USA). 4 Dec 1987. 7p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE90012314. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The Metal Industries Development Center (MIDC) welding and materials research center develops joining specifications and procedures for use by Taiwanese industries. These facilities were toured, and various research activities in dissimilar metals joining, robotic welding and machining, and computer aid design/drafting – computer aid management (CADD-CAM) control systems for casting and machining were presented by the MIDC staff researchers.

The certification examination was conducted for twenty-eight employees of MIDC, Tai-Petroleum, and several other manufacturing and construction companies. A seminar for the participants was presented. Topics of discussion were principally those relating to the CWI program, its intent, certification guidelines, recertification, responsibilities, and code of ethics.

40998 (PB–90-212770/XAB) **Development of high-strength sour-resistant oil-country tubular goods.** Asahi, H.; Sogo, Y.; Ueno, M.; Higashiyama, H. Nippon Steel Corp., Tokyo (Japan). ©Jan 1988. 7p. Available from NTIS, PC A05/MF A01.

Text in Japanese. Included in Seitetsu Kenkyu, No. 328, 16-21(1988).

The effects of metallurgical factors on the sulfide stress cracking (SSC) resistance of low-alloy steel with yield strength in the range from 700 to 900 MPa were studied mainly by the constant load test method. Based on the effects of elements on SSC resistance and the relation between intergranular fracture area and sigma, a new index of SSC resistance is presented. Using the index, the effects of metallurgical factors on SSC resistance can be well explained in a consistent manner. The results of the fundamental studies show that it is necessary for the design of high-strength SSC-resistant steel to adjust the chemical composition and grain size so as to obtain the hardenability necessary for the formation of fully martensitic structure and to obtain a yield strength lower than sigma. The sour-resistant oil country tubular goods with 100 and 105 ksi yield strengths were produced based on the results of the studies. They exhibited excellent SSC resistance.

40999 (PB–90-869348/XAB) **Vacuum-deposition equipment and techniques. June 1972-March 1990 (A Bibliography from the International Aerospace Abstracts data base). Report for June 1972-March 1990.** National Technical Information Service, Springfield, VA (USA). May 1990. 61p. Available from NTISPC N01/MF N01.

Supersedes PB–88-859657; U.S. sales only.

This bibliography contains citations concerning techniques and equipment for the vacuum deposition of a wide variety of materials. Topics include thin film devices, solar cells, erosion resistant coatings, photocathodes, optical fibers, and microelectronic systems. The vacuum deposition of corrosion resistant coatings for high temperature applications is also included. (This updated bibliography contains 115 citations, 13 of which are new entries to the previous edition.)

41000 (PB–90-869413/XAB) **Superconducting Nb-Sn, Nb-Ti, and Va-Ga: Critical current studies. January 1977-January 1990 (A Bibliography from the INSPEC: Information Services for the Physics and Engineering Communities data base). Report for January 1977-January 1990.** National Technical Information Service, Springfield, VA (USA). May 1990. 196p. Available from NTISPC N01/MF N01.

Supersedes PB–87-860730.

This bibliography contains citations concerning experimental and theoretical studies of critical currents in niobium-tin, niobium-titanium, and vanadium-gallium composite superconductors. Developments and evaluations of superconducting multifilaments, wires, tapes, cables, and films for commercial applications are presented. The effects of magnetic fields, critical temperatures, additives, and stress and strain limits on superconducting critical currents are discussed. (This updated bibliography contains 360 citations, 169 of which are new entries to the previous edition.)

41001 (SAND–89-2345) **Solderability testing of Kovar with 60Sn40Pb solder and organic fluxes.** Vianco, P.T.; Hosking, F.M.; Rejent, J.A. Sandia National Labs., Albuquerque, NM (USA). May 1990. 48p. Sponsored by U.S. DOE Management & Administration. DOE Contract AC04-76DP00789. Order Number DE90013643. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The solderability of 60Sn40Pb solder on Kovar was examined as a function of surface-cleaning procedure, flux, and solder-bath temperature. Organic-acid fluxes were more effective at lowering the contact angle than was a mildly activated, rosin-based (RMA) flux on chemically etched Kovar. The contact angles were as low as $29° \pm 5°$ as compared to $61° \pm 11°$, respectively. Varying the solder temperature through the range of 215°C to 288°C caused an insignificant change in the contact angle for the RMA flux and a decrease of the contact angle for a candidate water-based, organic-acid flux. The dilution strength of the flux and the elapsed cleaning time significantly influenced the solder-flux interfacial tension, γ_{LF}. T-peel strengths of Kovar-60Sn40Pb-OFHC copper joints had a low correlation with the contact angle derived from the solderability experiments. The results of the solderability tests and the T-peel mechanical tests, and subsequence microanalysis of the as-soldered and T-peel samples revealed that the best results for the RMA flux were achieved by using an electropolishing procedure and a solder temperature of 240°C to 260°C. A relatively low contact angle of $31° \pm 2°$ was observed, with no evidence of cracking or thick-film intermetallic formation at the Kovar-solder interface. T-peel strengths were nominally $9.4° \pm 0.5 \times 10^6$ dyn/cm. 21 refs., 36 figs., 11 tabs.

41002 (SAND–90-0016C) **Uptake and release of hydrogen in palladium by weakly-bound sites.** Richards, P.M.; Kay, B.D.; Wampler, W.R. Sandia National Labs., Albuquerque, NM (USA). [1990]. 15p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. (CONF-9009141–3: International symposium on metal-hydrogen systems, Banff (Canada), 2-7 Sep 1990). Order Number DE90013309. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Evidence is reviewed for the role played in the uptake and release of hydrogen in Pd by weakly bound sites, especially when the normal strong chemisorption sites are saturated. These weak sites seem to be much more effective in release than in uptake. It is not clear in all cases whether the sites are distinct subsurface or alternate ones on the surface, or whether there is a strong reduction of binding at high coverage which weakens the normal sites. 26 refs., 2 figs.

41003 (UCRL-ID–103911) **Experimental study of the optical constants of metals at high temperatures.** Havstad, M.A. Lawrence Livermore National Lab., CA (USA). May 1990. 45p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract W-7405-ENG-48. Order Number DE90014732. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This document summarizes the status of optical and radiative studies of selected metals at high temperature and serves as a dissertation proposal to the Thermosciences Division of the Department of Mechanical Engineering at Stanford University. This dissertation proposal summarizes work in progress. The final dissertation will be published in August 1990. Detailed descriptions of methods, results, and prior work will be fully reported in the dissertation and later in the open literature. 46 refs.

41004 (UCRL-JC–103259) **Characteristics of copper shaped-charge liner materials at tensile strain rates of 10^4 s^{-1}.** Gourdin, W.H. Lawrence Livermore National Lab., CA (USA). 29 May 1990. 17p. Sponsored by U.S. Department of Defense; U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-900818–2: International conference on shock wave and high-strain-rate phenomena in materials, San Diego, CA (USA), 12-17 Aug 1990). Order Number DE90013291. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

We have studied the mechanical behavior of 81-mm shaped-charge liners made from oxygen-free electronic (OFE) and electrolytic tough pitch (ETP) copper at tensile strain rates of 10^4 s^{-1} by using electromagnetic ring expansion. The OFE copper was processed to yield an uniform grain size of approximately 25 μm, whereas the ETP material was reportedly processed in such a way as to encourage excessive grain growth and a broad distribution of grain sizes. However, the microstructures of the materials we studied are all similar, and we find no evidence of gross secondary grain growth in the ETP liners, although they do contain oxide inclusions. The OFE liners are characterized by reproducible stress-strain relationships nearly identical to independently processed OFE copper of comparable grain size. The flow stress of the ETP specimens, in contrast, is both lower and generally more erratic than that of the OFE specimens. Elongation at failure for the OFE linear materials are consistently large (0.55 ± 0.01) and are significantly larger than values observed for annealed 10-μm OFE

(0.49 ± 0.04). The ETP materials appear to show somewhat less elongation at failure, although their erratic behavior makes comparisons difficult. We suggest that the erratic behavior of ETP shaped-charge liners under test and their poor performance relative to OFE copper are the result of chemical impurities and related microstructural nonuniformities, rather than differences in grain size alone. 12 refs., 9 figs., 2 tabs.

41005 (WSRC-tr–136) **Comparison of mixing characteristics in bottom-blowing ladle, LD converter, and RH degassing process.** Watanabe, Yoshio (Nagoya Univ. (Japan)); He, Ji-Cheng; Asai, Shigeo; Muchi, Iwao. Westinghouse Savannah River Co., Aiken, SC (USA). [1990]. 21p. Translated from Tetsu To Hagane (Japan); 69: No. 9, 1160-1166(1983). Sponsored by U.S. DOE Defense Programs. DOE Contract AC09-89SR18035. Order Number DE90011534. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The correlation between mixing time (τ) and mixing power density (ε) is confirmed through water model experiments. In flow controlled predominately by inertia or turbulent viscous force, τ is proportional to $\varepsilon^{-1/3}L^{\gamma}$ where the power (γ) to vessel size (L) depends on the vessel type. The value of γ reflects the turbulent structure of agitated liquid and it is an essential factor for scale-up. Thus, the precise information of turbulence, i.e., the velocity variation is measured by a hot-wire anemometer and a spectral analysis of the velocity fluctuation is computed by the method of FFT(Fast Fourier Transform). The dissipation energy of turbulence ($\bar{\varepsilon}'$) can be evaluated from the information of the spectral analysis. A correlation between τ and $\bar{\varepsilon}'$ is presented in a unified fashion without regard to the kind of vessels.

41006 Simulating corrosion-erosion mass transfer using plaster models. Griffith, P.; de Freitas, G. *Transactions of the American Nuclear Society (USA),* 59: 356-360 (1989). (CONF-890604–: Annual meeting of the American Nuclear Society, Atlanta, GA (USA), 4-8 Jun 1989).

Corrosion-erosion is a term that covers a variety of processes leading to the removal of metal in low-carbon steel piping conveying water or steam/water mixtures at a temperature of 150 ± 50°C. One of the most important of these processes is corrosion-dissolution. This is most likely to occur where disturbances or fittings cause local high velocities and thus high mass transfer coefficients. The wear equation, which requires the local mass transfer coefficient, is presented. This paper presents a way of determining the local mass transfer coefficient. This paper reports measurements of both local and nominal mass transfer coefficients on a plaster model of a defective weld in a pipe. Welds are particularly important because they are often the place where wear is the greatest and the pipe is most severely thinned.

41007 Structure and phases of the Au(001) surface: X-ray scattering measurements. Mochrie, S.G.J. (Physics Department, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139 (USA)); Zehner, D.M.; Ocko, B.M.; Gibbs, D. *Physical Review Letters (USA),* 64(24): 2925-2928 (11 Jun 1990). DOE Contract AC02-76CH00016 ;AC05-84OR21400.

X-ray diffraction is used to study the phase behavior and structure of the Au(001) surface between 300 K and the triple point. For $T>1170$ K, the x-ray reflectivity is consistent with a thin, disordered surface film. At 1170 K, there is a reversible transition to an incommensurate, hexagonal overlayer on top of the square substrate. At 970 K, the orientation of the hexagonal layer rotates discontinuously by 0.81° with no observable change in incommensurability.

41008 Size-dependent effects in the photodissociation spectra of $Sr^+(NH_3)_n$ = 1-4. Shen, M.H. (Univ. of Rochester, NY (USA)); Farrar, J.M. *Journal of Physical Chemistry (USA),* 93(11): 4386-4389 (1 Jun 1989).

A tandem mass spectrometer has been used to obtain total photodissociation absorption spectra of $Sr^+(NH_3)_n$, n = 1, 2, 3, and 4, in the wavelength region from 540 to 900 nm. The spectra of $Sr^+(NH_3)$ and $Sr^+(NH_3)_2$ show similar patterns, with a broad and intense band peaking near 580 nm. The absorption bands of $Sr^+(NH_3)_3$ and $Sr^+(NH_3)_4$ display significant changes: in addition to the remaining absorption near 580 nm, a new strong absorption feature appears with the peak position centered around 680 nm for $Sr^+(NH_3)_3$ and beyond 900 nm for $Sr^+(NH_3)_4$. A possible predissociation mechanism through excited electronic states is discussed briefly for $Sr^+(NH_3)$ and $Sr^+(NH_3)_2$. A solvated ion-pair formation model, based on our experimental results and simple energetic considerations, is proposed in rationalizing the observed spectral features in $Sr^+(NH_3)_3$ and $Sr^+(NH_3)_4$. The authors propose that intramolecular electron transfer within the clusters serves as a diagnostic of the transition from gas-phase toward condensed-phase behavior.

41009 Chemistry of cyclopentadienyliron dicarbonyl dimer and ferrocene in zeolite Y cavities: Anchoring organometallic fragments into microporous solids. Moller, K. (Univ. of New Mexico, Albuquerque (USA)); Borvornwattananont, A.; Bein, T. *Journal of Physical Chemistry (USA),* 93(11): 4562-4571 (1 Jun 1989).

The intracavity chemistry of $[CpFe(CO)_2]_2$ (1) and ferrocene in different acid forms of zeolite Y has been studied with EXAFS, in situ FTIR, and TPD-MS spectroscopies. Depending on the stoichiometry of zeolite protons vs the amount of starting complex 1, the complex is either oxidatively cleaved into $CpFe(CO)_3^+$ (2) and $CpFe^+$ coordinated to the zeolite, or protonated to form dimeric $[CpFe(CO)_2]_2H_+$ (3). It is shown that the stability of all complexes is influenced by the intracavity concentration of the zeolite-bridged hydroxyl groups. The cationic monomer 2 is stable up to 500 K in the highly acidic zeolite host, whereas the protonated dimer decomposes above 400 K. At higher temperatures, all carbonyl ligands are split off from the iron complexes, and the remaining dominant fragments are identified as $CpFe(OZ)_n$ (n = 2-3), bonded to the zeolite host structure via oxygen coordination. Similar fragments are formed upon thermal decomposition of ferrocene in the zeolite.

41010 Electronic structure of palladium clusters: Implications for cold fusion. Lohr, L.L. (Univ. of Michigan, Ann Arbor (USA)). *Journal of Physical Chemistry (USA),* 93(12): 4697-4698 (15 Jun 1989).

Electronic structure calculations at the ab initio HF/STO-3G level are reported for the octahedral clusters Pd_6^{2-}, Pd_6^{12-}, Pd_6H^-, and Pd_6H_2; these clusters serve as models for hydrogen (deuterium) in Pd metal. Electrostatic potentials, fields, and field gradients at various positions in the neighborhood of the octahedral hole are discussed. Forces sufficient to force two deuterium nuclei significantly closer than in diatomic D_2 appear unlikely.

41011 Radiolytic production and properties of ultrasmall CdS particles. Hayes, D. (Argonne National Lab., IL (USA)); Swayambunathan, V.; Micic, O.I.; Nenadovic, M.T.; Meisel, D. *Journal of Physical Chemistry (USA),* 93(11): 4603-4608 (1 Jun 1989). DOE Contract W-31-109-ENG-38.

The radiolytic production of CdS particles from solutions containing cadmium ions and a thiol (3-mercapto-1,2-propanediol, RSH) is described. The production of the colloids is initiated by the reaction of solvated electron with the thiol to release HS^- ions. The polynuclear complexes of cadmium with the thiolate form of RSH act as moderators to the growth of the particles and allow reproducible production of practically any predetermined size particles. The complexes at the surface of the particles also stabilize the particles for long periods of time. The particles are strongly fluorescent from size of ca. 8 Å in radius. Excess electrons in these particles lead to bleaching of the exciton band due to Coulomb screening effects. At higher doses, formation of cadmium atoms leads to increased absorption in the visible range.

41012 Electrical-field-driven electron self-exchange in a mixed-valent osmium(II/III) bipyridine polymer. Solid-state reactions of low exothermicity. Jernigan, J.C. (Univ. of North Carolina, Chapel Hill (USA)); Surridge, N.A.; Zvanut, M.E.; Silver, M.; Murray, R.W. *Journal of Physical Chemistry (USA),* 93(11): 4620-4627 (1 Jun 1989).

The dynamics of electrical-field-driven solid-state electron transfers between Os(II) and Os(III) sites in the 1:1 mixed-valent redox polymer poly[$Os(II/II)(bpy)_2(vpy)_2$]$(ClO_4)_{25}$ (bpy = bipyridine; vpy = vinylpyridine) are described. The nonlinear molecular conductivity of the polymer is modeled as an experimentally controllable intersite free energy gradient imposed by the electrical field. Electron self-exchange rates are analyzed as a function of free energy and temperature from 83 to 295 K with both classical and semiclassical

electron-transfer theories. The analysis shows that room-temeprature electron transfers lie near the high-temperature limit of classical behavior with a thermal barrier of 7-8 kcal/mol, but those at lowered temperature exhibit non-Arrhenius behavior and involve a nuclear tunneling mechanism. A single-frequency vibronic model gives 250 cm^{-1} as the vibrational energy and ca. 7 cm^{-1} as the electronic coupling term H_{AB}. We derive an apparent intersite reaction free energy that is 3-8 times larger than those estimated from the applied voltage bias ΔE divided by the number of monolayers of osmium complex sites in the film. This effect may arise from imperfections in contacting electrodes to the 100-500-nm mixed-valent film or from a dispersion of barrier heights caused by clustering in the polymer structure or from nonscreened Coulombic interactions.

41013 Interfacial factors that affect the photoefficiency of semiconductor-sensitized oxidations in nonaqueous media. Becker, W.G. (Portland State Univ., OR (USA)); Truong, M.M.; Ai, C.C.; Hamel, N.N. *Journal of Physical Chemistry (USA),* 93(12): 4882-4886 (15 Jun 1989).

Three types of platinized n-type anatase titanium dioxide powders were synthesized for use as photosensitizers in the oxidation of α-methylstyrene in acetonitrile suspensions. The oxidized, reduced, and n-octyl surface derivatized powders had mean particle diameters which ranged from 6.2 to 6.8 μm and BET surface areas (N_2 adsorption) which varied from 72 to 75 m^2/g. Photooxidations that employed the synthesized oxidized powders had an incident monochromatic photon-to-product efficiency of 0.037 $\pm$ 0.002 using 366 nm light. This represents a 7.6-fold increase in the photoefficiency when compared with platinized commercial anatase. This increased efficiency is attributed to surface characteristics that promote interfacial charge transfer versus electron-hole recombination. The powders posses a high roughness factor (approximately 300) and a surface topography that can be described by a fractal dimension ($D \approx 3.0$). An additional 2.3-fold increase over the synthesized oxidized powders is realized for the n-octyl-derivatized powders. This additional improvement is attributed to an increase in the surface affinity of the semiconductor particles for the nonpolar hydrocarbon starting material.

41014 Effects of palladium particle size and palladium silicide formation on fourier transform infrared spectra of CO adsorbed on Pd/SiO_2 catalysts. Sheu, Lienlung (Northwestern Univ., Evanston, IL (USA)); Karpinksi, Z.; Sachtler, W.M.H. *Journal of Physical Chemistry (USA),* 93(12): 4890-4894 (15 Jun 1989).

Two major modes of CO adsorption on SiO_2-supported Pd reflect different extents of back-donation, which is, at least in part, controlled by the local electron density at the adsorption site. The fraction of CO in the bridging mode (B) increases and that of the linear mode (L) decreases, with increasing size of the Pd particles, indicating high electron density at Pd atoms in terraces of close-packed crystal faces, in agreement with Smoluchowski's classical model. For samples reduced at 300°C our data points and those of other authors are located on a common curve of B/L vs metal dispersion. Extensive reduction at 600°C results in significantly lower B/L values, attributed to the incipient formation of a palladium silicide. Oxidation followed by reduction at 300°C destroys the silicide, and the B/L value returns to the original curve.

41015 Formation of electronically excited Mn_xO from the oxidation of small manganese clusters. Devore, T.C. (Georgia Institute of Technology, Atlanta (USA)); Woodward, J.R.; Gole, J.L. *Journal of Physical Chemistry (USA),* 93(12): 4920-4923 (15 Jun 1989).

The chemiluminescent reactions of manganese atoms and clusters with ozone have been studied under multiple-collision conditions. Manganese atoms entrained in room-temperature argon or helium react with ozone to form the lowest lying MnO^* $A^6\Sigma^+$ excited electron state [Mn to O_3 + Ar (He) $\rightarrow$ $MnO^*(A^6\Sigma^+)$ + O_2 + Ar (He)], producing a strong chemiluminescent signal corresponding to the MnO $A^6\Sigma^+$-$X^6\Sigma^+$ band system. A high flux of manganese vapor is entrained in liquid N_2 cooled argon to induce clustering. This entrained mixture subsequently reacts with ozone to produce a new complex emission system (accompanies MnO A-X system) containing at least 72 bands and extending from 720 to 970 nm. The new system, which is not present when the carrier gas is not cooled, increases precipitously with entrainment gas cooling and increased metal flux. The observed ands are fit within experimental error by the expression $\nu_{v1},v1'',\nu_{3'},\nu_{3''}$ = 12512 + $600\nu_1'$ - $534\nu_1''$ + $360\nu_3'$ -$306\nu_3''$, where all values are in cm^{-1}. The ground-state spacing of 306 cm^{-1} is assigned as an Mn-Mn stretch. The 534-cm^{-1} spacing is assigned to an MnO stretch, and the emitting molecule is believed to be the asymmetrical Mn-Mn-O isomer. The Mn-Mn stretch frequency is in excellent agreement with a frequency estimated for Mn_2^+ by averaging the derived force constants for Mn_2 and Cr_2. The MnO stretching frequency is considerably lower than the 840-cm^{-1} diatomic frequency, lying intermediate to those of KO (384 cm^{-1}) and CaO (733 cm^{-1}).

41016 Cesium-133 NMR studies of cation siting and site exchange dynamics in hydrated CsNa-A zeolite. Ahn, M.K. (Indiana State Univ., Terre Haute (USA)); Iton, L.E. *Journal of Physical Chemistry (USA),* 93(12): 4924-4927 (15 Jun 1989). DOE Contract W-31-109-ENG-38.

Variable-temperature cesium-133 NMR measurements have been made on hydrated Cs-exchanged Linde-4A zeolite containing 3.8 Cs^+ ions per unit cell. At room temperature there is rapid site exchange of the Cs^+ ions, so that the NMR spectrum is that of a single time-averaged environment. At temperatures below 238 K, the exchange is slowed sufficiently to permit the resolution of two resonances. These resonances can readily be assigned to Cs^+ ions at eight-ring sites and six-ring sites, which are distinguished by their large chemical shift difference of 106 ppm in the zeolite. The lifetimes and the population ratio of 2.3 for the two Cs^+ ion sites are obtained by fitting the NMR line shapes at various temperatures using a set of modified Bloch equations for a two-site exchange process. An Arrhenius activation energy of 38 kJ/mol for the cationic site exchange process in A-type zeolites is obtained from the lifetimes of Cs^+ ions. The rapid rate of site exchange establishes unequivocally that the six-ring site ion is on the α-cage side of the ring.

41017 Nonlinear surface-enhanced spectroscopy of silver colloids and pyridine: Hyper-Raman and second-harmonic scattering. Johnson, C.K. (Univ. of Kansas, Lawrence (USA)); Soper, S.A. *Journal of Physical Chemistry (USA),* 93(21): 7281-7285 (19 Oct 1989).

Surface-enhanced hyper-Raman scattering by pyridine was observed in aqueous silver citrate sols. Surface enhancement factors of several pyridine vibrations were measured and range from 10^3 to 10^6. The strongest enhancements were observed in the totally symmetric vibrations ν_{12}, ν_1, ν_{6a}, and ν_{8a} and the b_2 vibration ν_{6b}. The surface enhancements observed are larger than predicted by electrodynamic theories of surface enhancement for simple spherical or spheriodal particles, but relative enhancements are consistent with electromagnetic surface enhancement selection rules for hyper-Raman scattering. Elastic incoherent scattering in Ag sols was observed at twice the laser frequency. The intensity of the elastic component was 10^4 to 10^6 times more intense than hyper-Rayleigh scattering from bulk pyridine and increased upon addition of pyridine to the silver sols.

41018 In situ photoluminescnece of TiO_2 as a probe of photocatalytic reactions. Anpo, Masakazu (Univ. of Osaka Prefecture (Japan)); Tomonari, Masanori; Fox, M.A. *Journal of Physical Chemistry (USA),* 93(21): 7300-7302 (19 Oct 1989).

The addition of unsaturated hydrocarbons such as 1-C_4H_8 and $C_2H_5C{\equiv}CH$ onto the TiO_2 catalyst causes an increase of the intensity of the photoluminescence (PL) of the catalyst as a radiative surface process from photoformed electrons and holes. The extent of the PL enhancement strongly depends on the ionization potential of the added compounds, i.e., the lower the ionization potential of the added compound, the larger the PL intensity. A parallel relationship between the enhancement of the PL of the TiO_2 by the addition of unsaturated hydrocarbons and the rate of photocatalytic hydrogenation of these compounds with H_2O on the TiO_2 catalyst suggests that these surface processes are closely associated, with both being crucially dependent on the binding of the added molecules to the TiO_2 surface.

41019 Structure and dynamics of dimethylammonium ions in solids using ^2H quadrupole echo spectra. Ikeda, Ryuichi (Institute for Molecular Science, Okazaki (Japan)); Kubo, Atsushi;

McDowell, C.A. *Journal of Physical Chemistry (USA)*, 93(21): 7315-7319 (19 Oct 1989).

^2H NMR powder spectra, obtained by Fourier transforming the quadrupole echo signals, were recorded for $[(CD_3)_2NH_2]_2MCl_6$ (M = Sn, Te) to elucidate motional effects on the line shapes. The observed spectra were analyzed by comparison with line shapes calculated for various jump angles of the CD_3 group, differences in the cation jump rates, and interpulse spacing times. For both complexes there was a narrowing of the spectral width near room temperature which we associated with a new motional process of the cations. Spectra with a large asymmetry of the electric field gradient tensors, associated with the narrowing process, are explained well by assuming a 180° flip of the cation about its C_2 axis. From the line-shape analysis, the C-N-C bond angles in the tin and tellurium complexes are evaluated as 116.8° and 119.0°, respectively. The ND_2 bond angle was also determined to be 103.6° for $[(CH_3)_2ND_2]_2SnCl_6$. Activation energies and correlation times of the 180° flips of the cations were derived and compared with those of the fully protonated cations, and those for 90° rotational jumps of the complex anions.

41020 Absorption by ground-state lead atoms of the 283.3-nm resonant line from a lead hollow cathode lamp. An absolute number density calibration. Simons, J.W. (New Mexico State Univ., Las Cruces (USA)); Oldenborg, R.C.; Baughcum, S.L. *Journal of Physical Chemistry (USA)*, 93(21): 7336-7338 (19 Oct 1989).

An accurate absolute number density calibration curve for absorption by gaseous lead atoms of the 283.3-nm resonant line from a typical lead hollow cathode lamp is reported. This calibration shows the usual curvature in the Beer-Lambert plot for atomic absorption at moderate to high absorbances that is commonly attributed to self-absorption leading to line reversal in the source and/or preferential absorption at the line center when the absorber temperature is not much greater than the source Doppler temperature. A theoretical calculation utilizing a Doppler-limited Fourier transform spectrum of the 283.3-nm emission from the lamp and a tabulated value of the absorption cross section and accounting for the isotopic and nuclear hyperfine components in both the emission and absorption due to naturally occurring lead quantitatively reproduces the experimental calibration curve without any parameter adjustments. It is found that the curvature in the Beer-Lambert plot has more to do with the fact that the absorbing and emitting atoms are a mixture of isotopes giving several isotopic and nuclear hyperfine transitions at slightly different frequencies than it does with preferential absorption at line centers.

41021 Zero-field splitting of the lowest excited state of $[Os(bpy)_3]^{2+}$ doped into $[Ru(bpy)_3](PF_6)_2$. Braun, D. (Universitaet Regensburg (Germany, F.R.)); Yersin, H.; Schweitzer, D. *Journal of Physical Chemistry (USA)*, 93(22): 7555-7556 (2 Nov 1989).

A zero-field optically detected magnetic resonance (ODMR) signal has been observed at T = 1.5 K for $[Os(bpy)_3]^{2+}$ doped into a matrix of single-crystal $[Ru(bpy)_3](PF_6)_2$. In the investigated microwave frequency range of 2 GHz $\leq \nu \leq$ 6 GHz, a resonance is seen at 4.56 GHz (≈ 0.152 cm^{-1}) corresponding to the lowest excited state of the dopant. Thus, it is shown that this state is split into sublevels. From the occurrence of the ODMR signal, it follows that the relaxation rates between the sublevels are smaller than other deactivation rates.

41022 O_2^- formation in Nafion by electron transfer from Ti^{3+}. The effect of Al^{3+} as cocation. Alonso-Amigo, M.G. (Univ. of Detroit, MI (USA)); Schlick, S. *Journal of Physical Chemistry (USA)*, 93(21): 7526-7528 (19 Oct 1989).

The superoxide radical anion O_2^- has been detected by electron spin resonance (ESR) in dry Nafion perfluorinated membranes neutralized by Ti^{3+}. The most likely mechanism for O_2^- formation is electron transfer from Ti^{3+}. The g values for O_2^- at 77 K are 2.0029, 2.0090, and 2.0193, ± 0.0005, and are typical of the superoxide radical associated with a Ti^{4+} center. The O_2^- radical is motionally rigid and stable below 300 K. Above 310 K the signal disappears rapidly. Evacuation of the sample results in the appearance of the ESR spectrum of freely rotating molecular oxygen, trapped in the membranes. The rates of O_2^- formation and of Ti^{3+} disappearance can be followed by ESR and are significantly enhanced by the presence of Al^{3+} cations, especially for Al^{3+} mole fractions larger than 0.5 in the cation mixture. We suggest that this effect is due to the reduced clustering of Ti^{3+} in Nafion, in the presence of Al^{3+}. The results presented are thought important for an understanding of isotactic polymerization processes by Ziegler-Natta catalysts.

41023 Piezochromism in copper(II) cation distortion isomers: Pressure-induced changes in the solid-state geometry of (diethylenetriamine)(2,2′-dipyridylamine)copper(II) complexes. Bray, K.L. (Univ. of Illinois, Urbana (USA)); Drickamer, H.G. *Journal of Physical Chemistry (USA)*, 93(22): 7604-7609 (2 Nov 1989).

The effects of high pressure on $[Cu(dien)(bipyam)]X_2 \cdot nH_2O$ (dien = diethylenetriamine, bipyam = 2,2′-dipyridylamine; X = Cl$^-$, n = 2(1); X = ClO_4^-, n = 1 (2); and X = NO_3^-, n = 0 (3)) are described. Pressure-dependent electronic spectroscopy indicates a continuous transformation of 1 and 2 from distorted to more regular square pyramidal configurations with increasing pressure. A rearrangement in 3 from a distorted trigonal bipyramidal to a distorted square pyramidal configuration is observed over a pressure range of 30 kbar beginning at 45 kbar. Supporting infrared data are presented, and a discussion of the rearrangement based on cation-anion interactions is given. As dopants in a poly(4-vinylpyridine) environment all three complexes possess distorted square pyramidal configurations that become more regular at high pressure.

41024 Structures of dehydrated potassium zeolite L at 298 and 78 K and at 78 K containing sorbed perdeuteriobenzene. Newsam, J.M. (Exxon Research and Engineering Co., Annandale, NJ (USA)). *Journal of Physical Chemistry (USA)*, 93(22): 7689-7694 (2 Nov 1989).

The complete structures of dehydrated potassium zeolite L, $K_9Al_9Si_{27}O_{72}$, at 298 and 78 K and of the same zeolite at 78 K containing, on average, 1 molecule of perdeuteriobenzene/unit cell have been determined by powder neutron diffraction. Comparison with earlier literature data indicates that little change in structure accompanies dehydration, benzene sorption, or temperature change 298 K $\geq T \geq$ 78 K. The use of powder neutron diffraction has enabled a direct measure of the aluminum partitioning between the two inequivalent T-sites in the structure that, consistent with the complementary measure from bond length arguments, demonstrates a distinct aluminum preference for the 12-ring, SiI (T4) sites. The nonframework K^+ configuration shows only subtle changes over the range of conditions studied. Perdeuteriobenzene is observed at 78 K in capping positions above the channel wall (type D) K^+ cations. Simple atom-atom potential modeling of the benzene site based on the structural results yields only a small activation barrier to benzene molecule reorientation.

41025 Sandwich colloids of ZnO and ZnS in aqueous solutions. Rabani, J. (Hebrew Univ. of Jerusalem (Israel)). *Journal of Physical Chemistry (USA)*, 93(22): 7707-7713 (2 Nov 1989).

Colloid particles, composed of ZnO and ZnS particles in contact or ZnO colloid particles coated with ZnS, have been investigated. The effect of various amounts of ZnS on the ZnO visible emission was studied. The results show that ZnS quenches the ZnO visible emission by hole transfer; however, fast recombination between the electron and hole takes place at the ZnO-ZnS interface. This is reflected by a decrease in the yield of reduction of methyl viologen upon addition of ZnS to the ZnO-methyl viologen system.

41026 Many-body potentials and atomic-scale relaxations in noble-metal alloys. Ackland, G.J. (Department of Materials Science and Engineering, University of Pennsylvania, Philadelphia, PA (USA)); Vitek, V. *Physical Review, B: Condensed Matter (USA)*, 41(15): 10324-10333 (15 May 1990). DOE Contract FG02-87ER45295.

We derive empirical many-body potentials for noble-metal alloy systems in the framework of the Finnis-Sinclair model [Philos. Mag. A 50, 45 (1984)] which is based on a second-moment approximation to the tight-binding density of states for transition metals [F. Cyrot, J. Phys. Chem. Solids 29, 1235 (1968)]. The most important extension of the model is a simple incorporation of interspecies

interactions which involves fitting the alloying energies. The importance of properly accounting for the local atomic relaxations when constructing the potentials is emphasized. The observed principal features of the phase diagrams of the alloys are all well reproduced by this scheme. Furthermore, reasonable concentration dependences of the alloy lattice parameter and elastic constants are obtained. This leads us to suggest that fine details of the electronic structure may be less important in determining atomic structures than are more global parameters such as atomic sizes and binding energies.

41027 Ionization potentials of cobalt and nickel ions in the local-spin-density approximation. Dhar, S. (Department of Physics, Southern University, Baton Rouge, LA (USA)); Kestner, N.R. *Physical Review, B: Condensed Matter (USA),* 41(17): 11802-11806 (15 Jun 1990). DOE Contract FG05-87ER13674.

In this article we report on the ionization potentials of all configurations of the Co^{n+} and Ni^{n+} ions obtained via transition-state calculations using local-spin-density (LSD) potentials. The calculations were performed numerically with and without modifications of the local exchange potential for fractional occupation numbers. When the exchange potential is corrected for noninteger occupation numbers, a more consistent picture of the ionization process is obtained than that given by the LSD Kohn-Sham exchange. The agreement with experimental results is also significantly improved.

41028 Spin and orbital magnetism in 3*d* systems. Eriksson, O. (Center for Materials Science, Los Alamos National Laboratory, Los Alamos, NM (USA)); Nordstroem, L.; Pohl, A.; Severin, L.; Boring, A.M.; Johansson, B. *Physical Review, B: Condensed Matter (USA),* 41(17): 11807-11812 (15 Jun 1990).

We present self-consistent linear muffin-tin orbitals calculations for the cubic systems bcc Fe (α-Fe), YFe_2, FeAl, and Fe_3Al, and the hexagonal compounds $ThFe_5$ and Fe_2P. The spin-polarized calculations include the spin-orbit coupling and both the spin and orbital moments are reported. A simple model calculation is presented for α-Fe and from this it is concluded that the low orbital moments in the presently investigated 3*d* systems can be understood from the symmetry-adapted wave functions of the crystal.

41029 Cohesion and lattice stabilities in the 5*d* transition metals: Full versus muffin-tin potentials. Fernando, G.W. (Department of Physics, Brookhaven National Laboratory, Upton, New York 11973-5000 (USA)); Watson, R.E.; Weinert, M.; Wang, Y.J.; Davenport, J.W. *Physical Review, B: Condensed Matter (USA),* 41(17): 11813-11821 (15 Jun 1990). DOE Contract AC02-76CH00016.

First-principles linear augmented-Slater-type-orbital (LASTO) calculations have been carried out for the 5*d* transition metals Hf through Au. Among the various topics discussed are the stability of the hcp, fcc, and bcc phases, lattice volumes, and cohesion. Effects of the full versus the muffin-tin potential are also examined; in particular the ground state of Au is now correctly predicted to be fcc with use of the full potential. The hcp-fcc energy differences are a factor of 5 smaller than the corresponding fcc-bcc energy differences along the row.

41030 Electron band structure of a rare-earth metal: Tb(0001). Wu, S.C. (College of Engineering and Applied Science, State University of New York, Stony Brook, NY (USA)); Li, H.; Tian, D.; Quinn, J.; Li, Y.S.; Jona, F.; Sokolov, J.; Christensen, N.E. *Physical Review, B: Condensed Matter (USA),* 41(17): 11911-11918 (15 Jun 1990). DOE Contract FG02-86ER45239.

The electron band structure of Tb metal has been determined at room temperature by means of angle-resolved photoemission experiments on Tb(0001). For the first time in any rare-earth metal, the full dispersed $6s$-$5d_{3z^2}$$-1$-type Δ_1 band has been experimentally mapped along the $\Gamma\Delta A$ line. The two critical points of the Δ_1 band have been determined at $\Gamma_1^+ = -6.9$ eV and $\Gamma_4^- = -3.6$ eV. Dispersion and width of the initial Δ_1 band are in good agreement with relativistic linear muffin-tin orbitals calculations, but the absolute energy position deviates by -1.5 eV from theory. [Γ_1^+(calc)$= -5.3$ eV and Γ_4^-(calc)$= -2.3$ eV.] The initial Δ_1 band lies well below the Fermi level, also in agreement with theory, and the experimental value of the 4*f* binding energy is about -2.6 eV.

41031 Observation of surface to bulk interatomic Auger decay from Ta(100). Jensen, E. (Department of Physics, Brandeis University, Waltham, MA (USA)); Bartynski, R.A.; Weinert, M.; Hulbert, S.L.; Johnson, E.D.; Garrett, R.F. *Physical Review, B: Condensed Matter (USA),* 41(18): 12468-12472 (15 Jun 1990). DOE Contract AC02-76CH00016.

Core-valence-valence (*CVV*) Auger spectra from Ta(100) taken in coincidence with bulk and surface-shifted $4f_{7/2}$ core-level emission are presented. These data are compared with self-convolutions of calculations of the *d*-band densities of states for the surface and subsurface layers of a nine-layer slab. Agreement of the bulk spectrum with the calculation is good; agreement for the surface spectrum is very poor. These data are explained by proposing an interatomic surface to bulk Auger decay mode for the surface core hole that is competitive with the conventional *CVV* decay process.

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Refer also to citation(s) 40412, 40483, 40949, 40950, 40988, 40999, 41069, 41076, 41149, 42094, 42098, 42099, 42100

41032 (AD-A-219860/4/XAB) **Electrical transport through tunnel barriers and thin dielectric layers and physical properties of the high-Tc oxide superconductors. Final report, 1 April 1983-30 September 1989.** Beasley, M.R. Stanford Univ., CA (USA). Edward L. Ginzton Lab. 26 Mar 1990. 23p. Available from NTIS, PC A03/MF A01.

A broad research program was carried out aimed at the study of advanced superconducting electronic materials, superconducting tunnel junctions and the tunneling process itself. An artificially deposited amorphous silicon tunnel barrier was developed and applied (1) to tunneling studies of the A15 class superconductors Niobium tin and Vanadium gallium, and (2) to studies of the role of localized states on the tunneling process. The first practical sandwich-type superconducting/normal/superconducting Josephson junction device was developed based on a Nb-alloyed amorphous silicon barrier materials near a metal/insulator transition. The device appears to be an attractive alternative to shunted tunnel junctions for many applications. Finally, the first practical approach to the deposition of the new high-temperature oxide superconductors was developed-the so-called post-annealed approach-and the materials science of resulting films studied in detail. Tunneling studies of the high-temperature oxide superconductors were also carried out and provided the first evidence for the very large superconductive energy gaps now commonly reported for these materials.

41033 (AD-A-219864/6/XAB) **Development of damped metal-matrix composites for advanced structural applications. Technical report.** Updike, C.A.; Bhagat, R.B. Pennsylvania State Univ., University Park, PA (USA). Applied Research Lab. Apr 1990. 98p. (ARL/PSU/TR-90-004). Available from NTIS, PC A05/MF A01.

The development of damped metal matrix composite structures for advanced applications has been investigated by the use of two different approaches: (1) the development of metal matrix composites with high intrinsic damping compared to that of the matrix material, and (2) the development of coated metal matrix composites with high structural damping compared to that of the composite substrates. The two different approaches are analyzed in terms of their potential for improved damping and feasibility for structural applications. Damping was measured by the transverse vibration of free-free beams using the bandwidth technique by a laser vibrometer under ambient conditions. The damping measurements were made over a wide range of frequencies (.7 kHz to 25.6 kHz) at low strain amplitudes (10 to the -10 power to 10 to the -7 power). Materials investigated for their tensile stiffness, strength, and damping performance include mechanically alloyed (MA) Aluminum-Magnesium, SiC(p)/Aluminum-Copper (MA), SiC(p)/AL, AL2O3(p)/AL, SiC(W)/AL, planar random Gr/AL, unidirectional Gr/AL and unidirectional SiC(Nicalon)/AL composites. The effects of coatings of high damping metals (nitinol and incramute) on 6061-T6 AL and AL2O3(p)/AL substrates have also been studied. The AL-Mg (MA), SiC(p)/AL (MA), SiC(W)/AL and th AL2O3(p)/AL composites show no significant improvement in damping compared with that of the 6061-T6 AL.

41034 (AD-A-220211/7/XAB) **Stripline measurements of surface resistance: Relation to HTSC film properties and deposition methods.** Oates, D.E.; Anderson, A.C. Massachusetts Inst. of Tech., Lexington, MA (USA). Lincoln Lab. 1989. 14p. (MS-8356). Available from NTIS, PC A03/MF A01.

Pub. in SPIE, Vol. 1187 Processing of Films for High Tc Superconducting Electronics, 326-337(1989).

The measurement of microwave surface resistance, R sub s of thin films of high transition-temperature superconductors are described by the stripline resonator method. This method allows measurement of R sub s as a function of frequency from 0.5 GHz to 20 GHz and has a sensitivity of greater than 1 x 10 to the -7th power Ohms. R sub s films deposited by various methods has been measured, and a limited temperature dependence for one YBCO film is also reported. The results are related to the deposition methods and film properties.

41035 (AD-A-220423/8/XAB) **Effects of large doses of high-energy electrons on a $YBa_2Cu_3O_6$ + delta high-temperature superconductors. Master's thesis.** Wolfe, G.J. Naval Postgraduate School, Monterey, CA (USA). Dec 1989. 112p. Available from NTIS, PC A06/MF A01.

Two samples of $YBa_2Cu_3O_6(+)$ delta high temperature (93 K) superconductor samples were irradiated with 67 MeV electrons. Both samples were cut from the same parent, manufactured by the University of Houston. Radiation effects were studied by measuring resistance as a function of dose during exposure. The samples were exposed to dose up to 100 Mrads. One sample was irradiated at near room temperature, while the second sample was irradiated at 30 K, below the superconducting transition temperature. Resistance as a function of temperature data was obtained prior to and immediately after exposures for both samples. The samples evidenced little or no shifts due to radiation effects in either the normal state resistance or the transition temperature outside of measurement accuracies. Both samples showed evidence of overall crumbling and flaking of the leads, likely due to the continual thermal expansion and contraction of the different materials throughout the different measurements. These mechanical effects produced measurable changes in the normal state resistances. It is concluded that the $YBa_2Cu_3O_6(+)$ delta superconductor is significantly radiation-hard.

41036 (CONF-900218-4) **Investigation of dilute gelcasting alumina suspensions.** Omatete, O.O. (Oak Ridge National Lab., TN (USA)); Young, A.C.; Janney, M.A.; Adair, J.H. Oak Ridge National Lab., TN (USA). [1990]. 9p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC05-84OR21400. From 3. international conference on ceramic powder processing science; San Diego, CA (USA); 4-7 Feb 1990. Order Number DE90013830. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Gelcasting is a new near-net-shape forming process developed at the Oak Ridge National Laboratory. The effects of the gelcasting ingredients which include the gelling organic monomer, the dispersant (ammonium polymethacrylate), and the sintering aid (magnesium nitrate), have been investigated for their influence on the colloidal properties of suspensions of alumina in water. Two volume percent (vol %) alumina suspensions were examined by acid-base titrations, sedimentation, particle electrophoretic mobility, and specific conductance measurements. The effects of the additions of one, two or three of the ingredients in combination are reported. 8 refs., 3 figs.

41037 (CONF-900634-4) **High temperature strength of SiC whisker-reinforced silicon nitride composites.** Tiegs, T.N.; Becher, P.F.; Ferber, M.K.; Menchhofer, P.A. Oak Ridge National Lab., TN (USA). [1990]. 6p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC05-84OR21400. From 7. world ceramics congress: ceramics today-tomorrow's ceramics; Montecatini Terme (Italy); 24-30 Jun 1990. Order Number DE90013822. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The addition of SiC whiskers to Si_3N_4-based matrices results in improved flexural strength and fracture toughness at room temperature; however, at temperatures >1000°C, the strength can be lower than that of the monolithic material. This effect is a function of the impurity content introduced by the whiskers and the affect of such impurities on the composition of the intergranular glass phase. Other factors affecting the high-temperature strength are whisker type and content. 5 refs., 3 figs.

41038 (CONF-900738-1) **Preparation and magnetic measurements of single crystal $Tl_2Ba_2CaCu_2O_8$.** Liu, J.Z. (California Univ., Davis, CA (USA). Dept. of Physics); Jia, Y.X.; Klavins, P.; Shelton, R.N.; Downey, J.; Lam, D.J. Argonne National Lab., IL (USA). May 1990. 16p. Sponsored by U.S. DOE Energy Research. DOE Contract W-31109-ENG-38 ;W-7405-ENG-48. From 8. American conference on crystal growth; Vail, CO (USA); 15-20 Jul 1990. Order Number DE90013657. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

A novel self-flux growth technique has been used to prepare superconducting single crystals with transition temperatures, T_c, ranging from 105K to 124K in the Tl-Ca-Ba-Cu-O system. Measurements of the magnetic hysteresis and magnetic relaxation in $Tl_2Ba_2CaCu_2O_8$ crystals reveal extraordinary flux creep behavior that persists at low temperatures. These effects are attributed to the lack of effective pinning centers in these materials. 10 refs., 6 figs.

41039 (CONF-9005235-2) **Calculation of the solubilities of oxides in molten carbonates.** Blander, M. (Argonne National Lab., IL (USA)); Pelton, A. Argonne National Lab., IL (USA). [1990]. 14p. Sponsored by U.S. DOE Energy Research. DOE Contract W-31109-ENG-38. (CONF-900562-7: 7. international symposium on molten salts; Spring meeting of the Electrochemical Society, Montreal (Canada); Montreal (Canada), 6-11 May 1990; 6-11 may 1990). Order Number DE90013682. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Analyses of data on the solubilities of NiO in molten alkali carbonates M_2CO_3, provides values of thermodynamic parameters of the solution constituents $NiCO_3$, NiO, and M_2NiO_2 in an alkali carbonate solution. These data and data on the free energies of mixing of alkali carbonate mixtures permit one to calculate solubilities of NiO in the mixtures using molten salt solution theories. This procedure avoids the inconsitencies inherent in correlating oxide solubilities with intuitive acid-base concepts and is general enough to be used with other solvents (e.g., alkali sulfates and halides) and solutes (other oxides). 26 refs., 2 figs., 2 tabs.

41040 (DOE/ER/13183-4) **[Experimental and kinetic modeling of acid/base redox reactions over metal oxide catalysts].** Wisconsin Univ., Madison, WI (USA). Dept. of Chemical Engineering. [1990]. 30p. Sponsored by U.S. DOE Energy Research. DOE Contract FG02-84ER13183. Order Number DE90013835. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

During the past three years, our studies of metal oxide catalysts have been directed in several important areas. One of our major directions has been the development of microcalorimetry as a tool for the measurement and formulation of a thermodynamic scale of surface acidity. Studies in this area have involved a series of silica-supported metal oxides as well as several zeolite catalysts used in catalytic cracking. A second direction of research has been the preparation and study of thin-film oxide materials as models of vanadia/titania catalysts for the selective reduction of nitric oxide. These materials are well-suited for ultra-high vacuum investigations (e.g., XPS, AES, TPD) and they thereby provide valuable information about the kinetics and surface bonding energetics of the elementary steps comprising the reaction mechanism. Our studies funded by the Department of Energy have also involved microkinetic simulations of the oxidations of methane, methanol, formaldehyde and carbon monoxide over silica-supported molybdena and vanadia. The objective of this work was to determine whether a physically realistic reaction network of surface reaction steps could be constructed that would describe quantitatively the oxidation kinetics and selectivities of the above four reactants over a wide range of reaction conditions. The final direction that we have followed utilized solid state NMR techniques to characterize the coordination state of aluminum cations on silica-alumina catalysts and silica/alumina/molybdena materials. These studies give insight into the factors controlling the dispersion of alumina on silica and the mobility of molybdena on silica/alumina under oxidizing conditions at elevated temperatures. The following sections will describe in greater detail our results in each of the above four research efforts.

41041 (DOE/ER/45228–55) **Surfaces and interfaces of ceramics and metals: Progress report, July 1989–July 1990.** Arizona State Univ., Tempe, AZ (USA). Dept. of Physics. [1990]. 5p. Sponsored by U.S. DOE Energy Research. DOE Contract FG02-86ER45228. Order Number DE90014381. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The progress on the research program of this grant has continued on the same lines as before but new directions have been added as a result of serendipitous observations of surprising new phenomena. In the studies of MgO surfaces it was found that under particular circumstances a crystal could cleave on the (111) plane, forming a surface which, in principle, could be highly unstable but appears to be stabilized by a surface reconstruction. Also observations of MgO surfaces with high-angle annular-dark-field (HAADF) STEM imaging produced a new sort of surface contrast, explainable in terms of a new aspect of the channeling phenomenon. This report briefly discusses work on Magnesium Oxide surfaces, but also oxide surface structures, surface channeling and the study of interfaces and high-angle annular-dark-field STEM imaging.

41042 (FTINT–41-88) **Synthesis of HTSC monocrystals on the yttrium base.** Bondarenko, A.V.; Verkin, B.I.; Zubareva, M.O.; Obolenskij, M.A. AN Ukrainskoj SSR, Kharkov (Ukrainian SSR). Fiziko-Tekhnicheskij Inst. Nizkikh Temperatur. 1988. 13p. (In Russian). Order Number DE90633479. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Single crystal growth of $YBa_2Cu_3O_{6.5+x}$ using $BaCuO_2$-CuO flux method is presented. The structure of crystals is close to tetragonal with lattice parameters a=3,872 A, b=3, 898 A and c=11,700 A. Crystals up to 2x1x,03 mm exhibit block structure with the angle 1-2 deg between blocks. The surface of many crystals exhibits exstensive step decorations. Thermal annealing in oxygen flow increases the ratio b/a (a=3,833 A, b=3,898 A and c=11,700 A). The microtwinning along (200) and (020) directions is observed. The transition temperature depend upon the annealing conditions and varies from 30 to 90 K. 6 refs.; 6 figs.

41043 (LBL–29039) **Electron microscopy of transition-metal doped BiCaSrCuO superconductors.** Fortunati, K.L. Lawrence Berkeley Lab., CA (USA). Apr 1990. 38p. Sponsored by U.S. Department of Defense; U.S. DOE Energy Research. DOE Contract AC03-76SF00098. Grant MDA972-88-J-1002. Order Number DE90014184. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Superconductivity was discovered in 1911 when H. K. Onnes found no electrical resistance in Hg cooled to 4.1 K. Over one thousand additional "low temperature" superconductors were discovered prior to Bednorz and Muller's discovery of "high temperature" (40 K) superconductivity in BaLaCuO compounds in March of 1986. This discovery generated much scientific interest in oxide superconductors. Less than one year later the now well known YBaCuO class of superconductors raised the highest known superconducting transition temperature to 90 K, well above the boiling temperature of liquid nitrogen. In the following year, the highest recorded transition temperature was raised to 105 K by the BiCaSrCuO system. This system extended obtainable values of not only transition temperature, but also critical magnetic field, and critical current. This paper reviews the technology of superconductivity. 51 refs., 20 figs.

41044 (N–90-20393) **Electron beam induced damage in PECVD Si_3N_4 and SiO_2 films on InP.** Pantic, D.M.; Kapoor, V.J.; Young, P.G.; Williams, W.D.; Dickman, J.E. National Aeronautics and Space Administration, Cleveland, OH (USA). Lewis Research Center. Mar 1990. 17p. (NASA-TM–102544;E–5356;NAS–1.15:102544;CONF-8710376–: Symposium on dielectric films on compound semiconductors, Honolulu, HI (USA), 18-23 Oct 1987). Available from NTIS, PC A03/MF A01.

Phosphorus rich plasma enhanced chemical vapor deposition (PECVD) of silicon nitride and silicon dioxide films on n-type indium phosphide (InP) substrates were exposed to electron beam irradiation in the 5 to 40 keV range for the purpose of characterizing the damage induced in the dielectic. The electron beam exposure was on the range of 10^{-7} to 10^{-3} C/sq cm. The damage to the devices was characterized by capacitance-voltage (C-V) measurements of the metal insulator semiconductor (MIS) capacitors. These results were compared to results obtained for radiation damage of thermal silicon dioxide on silicon (Si) MOS capacitors with similar exposures. The radiation induced damage in the PECVD silicon nitride films on InP was successfully annealed out in an hydrogen/nitrogen (H2/N2) ambient at 400 C for 15 min. The PECVD silicon dioxide films on InP had the least radiation damage, while the thermal silicon dioxide films on Si had the most radiation damage.

41045 (N–90-21402) **Review and statistical analysis of the ultrasonic velocity method for estimating the porosity fraction in polycrystalline materials.** Roth, D.J.; Swickard, S.M.; Stang, D.B.; Deguire, M.R. National Aeronautics and Space Administration, Cleveland, OH (USA). Lewis Research Center. Mar 1990. 45p. (NASA-TM–102501;E–5298;NAS–1.15:102501). Available from NTIS, PC A03/MF A01.

A review and statistical analysis of the ultrasonic velocity method for estimating the porosity fraction in polycrystalline materials is presented. Initially, a semi-empirical model is developed showing the origin of the linear relationship between ultrasonic velocity and porosity fraction. Then, from a compilation of data produced by many researchers, scatter plots of velocity versus percent porosity data are shown for Al2O3, MgO, porcelain-based ceramics, PZT, SiC, Si3N4, steel, tungsten, UO2,(U0.30Pu0.70)C, and YBa2Cu3O(7-x). Linear regression analysis produced predicted slope, intercept, correlation coefficient, level of significance, and confidence interval statistics for the data. Velocity values predicted from regression analysis for fully-dense materials are in good agreement with those calculated from elastic properties.

41046 (ORNL/FTR–2649) **[Diffraction and crystallography]: Foreign trip report, August 3, 1987–August 21, 1987.** Busing, W.R. Oak Ridge National Lab., TN (USA). 28 Aug 1987. 9p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE90012323. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

This report describes a trip to Australia which includes the 14th International Congress of Crystallography, a satellite Symposium on Neutron Scattering, and a visit to the CSIRO Division of Protein Chemistry. Scientific information acquired in the areas of fiber diffraction, electron diffraction, diffractometer programs, potential energy modelling, high-temperature superconductors, macromolecular structure and drug design, and new computer technology is discussed.

41047 (PB–90-203845/XAB) **Effects of cold isostatic pressure on properties of Ni(Pb)-Sr-Ca-Cu-O superconductor.** Hiraoka, M. Mitsubishi Cable Industries Ltd., Tokyo (Japan). ©1989. 7p. Available from NTIS, PC A05/MF A01.

Text in Japanese. Included in Mitsubishi Cable Industries Review, No. 78, 1-6(1989).

Properties of Bi(Pb)-Sr-Ca-Cu-O superconductor have been improved by densifying the material by cold isostatic pressing (CIP). After the most preferable composition in terms of superconductivity was determined as Bi(0.7) Pb(0.3) Sr Ca Cu(1.5) Oy, temperarily sintered powder having this composition was CIP-ed with an applied pressure of 100-800MPa and subjected to long-term sintering. Density of sintering superconductor was improved in proportion to the increase in the applied pressure. By long-term sintering for around 200 hours, superior superconducting properties, 106.5K in Tc(R=0), 330A/sq cm in Jc(77K. magnetic field=0), were obtained.

41048 (PB–90-212713/XAB) **Development of machinable Si_3N_4-Bn composite ceramics.** Isomura, K.; Funahashi, T.; Uchimura, R. Kawasaki Steel Corp., Tokyo (Japan). ©1989. 7p. Available from NTIS, PC A07/MF A01.

Text in Japanese. Included in Kawasaki Steel Giho, Vol. 21, No. 4, 17-22(1989).

Advanced composite ceramics of the Si_3N_4-BN system have been developed. The Si_3N_4-BN composite ceramics (SNB) have been produced using a slipcasting technique, which utilizes homogeneous mixing of ultra-fine constituent ceramic powders, and N_2 gas pressure sintering. An essential feature of SNB is that it is possible to change widely their various properties by controlling the proportion of BN to Si_3N_4. The advantageous features of SNB are high thermal shock resistance, high corrosion resistance to molten metal, and excellent machinability while retaining relatively high strength, i.e., the bending strength of SNB with 20 wt. % BN is 200

MPa or over. The thermal shock resistance temperature is improved by 250 to 300C compared with Si3N4 monolithic ceramics by incorporating 20 wt. % BN. These features indicate that SNB are well suited to machine parts for various molten casting facilities and jigs for heat treatment.

41049 (PB-90-212747/XAB) **Preparation of YBa_2Cu_3Ox ceramics by spray-drying technique and its superconducting properties.** Nakamura, N.; Ishida, M.; Koseki, Y.; Shimotomai, M. Kawasaki Steel Corp., Tokyo (Japan). ©1989. 7p. Available from NTIS, PC A07/MF A01.

Text in Japanese. Included in Kawasaki Steel Giho, Vol. 21, No. 4, 36-41(1989).

A spray-drying technique was worked out to prepare high temperature superconducting ceramics YBa_2Cu_3Ox by using an aqueous solution of acetic salts of component metals. The spray-dried powders of about 1 microm in diameter were calcined at 900C in air followed by sintering at 950C. The apparent density of the sintered body amounted to 98% of the theoretical value. Its specific resistivity, a measure of density and homogeneity, was as low as 150 micro Ohms.cm at the onset temperature. Densification, however, caused microcracking, resulting in degradation of critical current density. Intergranular flux creep rate in the densified superconducting ceramics was found to be negligibly small in a magnetic field less than the lower critical field. A kinetic analysis yielded a value of 4 meV as activation energy of the intergranular flux creep.

41050 (Y/TR-90/4) **Concerning ternary metal boron nitrides.** Goubeau, J. (Stuttgart Univ. (Germany, F.R.). Lab. fuer Anorganische Chemie); Anselment, W. Oak Ridge Y-12 Plant, TN (USA). 1990. 15p. Translated from Zeitschrift fuer Anorganische und Allgemeine Chemie (German Democratic Republic); 310, 248-260(1961). Sponsored by U.S. DOE Defense Programs. DOE Contract AC05-84OS21400. Order Number DE90011539. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Thesis. Submitted by W. Anselment.

By heating of mixtures of lithium nitride (calcium nitride, barium amide) with boron nitride to 700–1000°C, ternary nitrides of these metals with boron were prepared. The compositions Li_3BN_2, $Ca_3B_2N_4$ and $Ba_3B_2N_4$ could be estimated by varying the proportions in the mixtures. The compounds formed have been identified by changes in color, by their good solubility in water or cold dilute hydrochloric acid, and by Debye-Scherrer photographs. Infrared spectra support the assumption of the ion $(N = B = N)^{3-}$, but in the calcium compound a polymeric ion is perhaps present besides the monomer. Similar experiments with potassium amide and the nitrides of magnesium, gallium and lanthanum have shown no results. 3 tabs.

41051 Raman microprobe of laser-induced surface damage regions in TiO_2 and ZrO_2 coatings. Friedrich, D.M. (Pacific Northwest Lab., Richland, WA (USA)); Exarhos, G.J. pp. 374-382 of Laser induced damage in optical materials. 1985. Bennett, H.E.; Guenther, A.H.; Milam, D.; Newnam, B.E. US Government Printing Office, Washington, DC (USA) (1988). DOE Contract AC06-76RL01830. (CONF-851052–: 17. annual symposium on optical materials for high-power lasers, Boulder, CO (USA), 28-30 Oct 1985).

The anatase-to-rutile phase transition, which attends pulsed laser-induced damage of anatase TiO_2 thin films, is studied by simultaneous microphotography and Raman microprobe. The damage is distributed across the damage area in regions of distinct morphology and spectra. In multilayer coatings, a mechanical surface-fracture zone surrounds a set of thin, layered flat rings of distinct but irregular boundaries. These rings surround a rough, pitted transparent central crater in the quartz substrate. Raman difference spectroscopy is used to reveal damage regions containing the rutile phase and regions devoid of TiO_2. Similarly, Raman microprobe spectra reveal the monoclinic crystalline form of ZrO_2 in damaged regions of amorphous ZrO_2 coatings. Finally, frequency shifts of the anatase $\neq_6$ line (nominally 143 cm^{-1}) are used to identify stress in laser-pulse irradiated anatase coatings.

41052 Creation of interface states at the silicon/silicon dioxide interface by UV light without hole trapping. Schubert, W.H. (Sandia National Labs., Albuquerque, NM (USA)); Seager, C.H.; Brower, K.L. pp. 415-420 of Chemistry and defects in semiconductor heterostructures: Volume 148. Kawabe, M.; Sands, T.D.; Weber, E.R.; Williams, R.S. Materials Research Society, Pittsburgh, PA (USA) (1989). DOE Contract AC04-76DP00789. (CONF-890426–: Spring meeting of the Materials Research Society, San Diego, CA (USA), 24-28 Apr 1989).

Photoinjection of electrons into silicon dioxide in metal-oxide-semiconductor capacitors with 3.5 eV light is shown to create interface states with no apparent hole trapping precursor. The creation rate of these interface states depends strongly upon whether injection is from the gate metal or the silicon substrate, and on the forming gas annealing sequence used to passivate growth-induced interface states. A mechanism involving electron-induced release of hydrogen in the oxide is consistent with some aspects of the data.

41053 Optical spectroscopic study of inverted cylindrical magnetron sputtering of $YBa_2Cu_3O_{7-x}$. Xi, X.X. (Department of Physics, Rutgers University, Piscataway, New Jersey 08854 (USA)); Wu, X.D.; Inam, A.; Li, Q.; Hemmick, D.; Findikoglu, A.; Venkatesan, T.; Chang, C.C.; Howard, R. *Applied Physics Letters (USA)*, 57(1): 96-98 (2 Jul 1990).

Optical spectroscopic studies of the plasma generated by inverted cylindrical magnetron sputtering of the high-temperature superconductor $YBa_2Cu_3O_{7-x}$ reveal strong ionic emissions from cation elements as well as from the sputter gases. The emissions of cationic ions are weakened drastically when O_2 is added into the sputter gas indicating the dominating role of ions in the reaction with oxygen to form gas phase oxides. The formation of gas phase oxides is proposed to be an important precursor step for the *in situ* deposition of $YBa_2Cu_3O_{7-x}$ thin films.

41054 Magnetization hysteresis and flux pinning in twinned and untwinned $YBa_2Cu_3O_{7-\delta}$ single crystals. Welp, U. (Argonne National Laboratory, Argonne, Illinois 60439 (USA)); Kwok, W.K.; Crabtree, G.W.; Vandervoort, K.G.; Liu, J.Z. *Applied Physics Letters (USA)*, 57(1): 84-86 (2 Jul 1990). DOE Contract W-31109-ENG-38.

Measurements of the magnetization hysteresis of the *same* crystal in the twinned and untwinned state reveal that pinning due to twinning planes may contribute a substantial, anisotropic fraction of the observed critical currents. A linear scaling between magnetization hysteresis and sample dimension shows that the twinned and untwinned crystal does not exhibit any subgranular effects.

41055 Crystallographically oriented superconducting $Bi_2Sr_2CaCu_2O_8$ by shock compaction of prealigned powder. Seaman, C.L. (Department of Physics, University of California, San Diego, La Jolla, CA (USA)); Early, E.A.; Maple, M.B.; Weir, S.T.; Nellis, W.J.; McCandless, P.C.; Brocious, W.F. *Applied Physics Letters (USA)*, 57(1): 93-95 (2 Jul 1990). DOE Contract W-7405-ENG-48.

Highly textured specimens of $Bi_2Sr_2CaCu_2O_8$ were obtained by shock compaction of powder at 30–140 kbar and by sintering. The compacts were characterized by x-ray diffraction, magnetic susceptibility, electrical resistance, optical microscopy, and scanning electron microscopy data. Preferential orientation with the *a-b* plane in the plane of the disk-shaped compacts was achieved by tapping platelet-shaped powder with a controlled size distribution, followed by shock compaction or by sintering. The shocked compacts were annealed to induce metallic resistance while maintaining preferential crystallographic orientation. The electrical and magnetic data demonstrate that shock compaction heterogeneously heats and bonds grain boundaries.

41056 Fermi surfaces of $YBa_2Cu_3O_{6.9}$ as seen by angle-resolved photoemission. Campuzano, J.C. (Argonne National Laboratory, 9700 South Cass Avenue, Argonne, IL (USA)); Jennings, G.; Faiz, M.; Beaulaigue, L.; Veal, B.W.; Liu, J.Z.; Paulikas, A.P.; Vandervoort, K.; Claus, H.; List, R.S. *Physical Review Letters (USA)*, 64(19): 2308-2311 (7 May 1990). DOE Contract W-31109-ENG-38.

We have carried out angle-resolved photoemission spectroscopy on single crystals of $YBa_2Cu_3O_{6.9}$. The crystals were cleaved *in situ*, under ultrahigh vacuum while the sample stage was cooled to 8 K. By observing the dispersion of the electron energy bands as they cross the Fermi energy, we have mapped the Fermi surfaces.

There is reasonable agreement between the experimental results and the predictions of band-structure calculations using the local-density approximation, as well as with positron annihilation experiments. Rather than δ holes, these results indicate that the Fermi surface of $YBa_2Cu_3O_{6.9}$ encloses $1+\delta$ holes, where δ is the doping level.

41057 Observation of a local structural change at T_c for $Tl_2Ba_2CaCu_2O_8$ by pulsed neutron diffraction. Toby, B.H. (Department of Materials Science and Engineering, University of Pennsylvania, Philadelphia, PA (USA)); Egami, T.; Jorgensen, J.D.; Subramanian, M.A. *Physical Review Letters (USA)*, 64(20): 2414-2417 (14 May 1990). DOE Contract W-31109-ENG-38.

Deviations in atomic positions from those of the average crystallographic structure of superconducting $Tl_2Ba_2CaCu_2O_8$ were studied by pair-distribution function (PDF) analysis of pulsed-neutron-scattering data. The PDF shows a clear change in the local structure at the onset of superconductivity. In addition to the previously observed local displacements of Tl and O within the Tl-O sheets, correlated displacements of O and Cu perpendicular to the Cu-O plane have been found. The arrangement of the O atoms appears to be different above and below T_c.

41058 Electronic structure of multiple vacancies in rutile TiO_2 by the equation-of-motion method. Halley, J.W. (School of Physics and Astronomy, University of Minnesota, Minneapolis, MN (USA)); Michalewicz, M.T.; Tit, N. *Physical Review, B: Condensed Matter (USA)*, 41(14): 10165-10170 (15 May 1990). DOE Contract FG02-84ER45173.

We report calculations of the electronic structure of a model of TiO_2 which contains oxygen vacancies. The model uses the full tight-binding model of Vos. We use a screened Coulomb potential and a soft positive core to describe the oxygen vacancy. We study the electronic density of states as a function of the thickness of a layer of TiO_2 and of the number of oxygen vacancies up to 10% vacancies. We show that the structure of the density of states in the neighborhood of the conduction-band edge cannot be even approximately described by a crystal-field calculation involving only a few metal ions near the vacancy. The evolution of the density of states as the layer is made thicker is described.

3606 Other Materials

Refer also to citation(s) 40376, 40504, 40505, 40556, 40557, 40572, 40701, 40842, 40942, 40988, 40999, 41033, 41036, 41037, 41131, 41134, 41135, 41136, 41137, 41163, 41169, 41185, 41187, 41194, 41201, 41316, 41317, 41322, 41504, 41805

41059 (AD-A–219838/0/XAB) **Center for cement composite materials. Final report, 29 October 1986-30 November 1989.** Young, J.F. Illinois Univ., Urbana, IL (USA). Dept. of Civil Engineering. Jan 1990. 70p. Available from NTIS, PC A04/MF A01.

The Center has produced very strong MDF cements and has made significant progress in enhancing the water resistance of the material. The important factors in controlling water sensitivity have now been identified and studies are in progress to quantify their influences. Cement hydration has been followed by a novel in-situ technique involving nuclear magnetic resonance. Fiber-matrix interactions in MDF laminates were also studied. Characterization of DSP pastes have shown that the matrix is microporous; mesopores are absent unless the material is allowed to dry out. This results in water adsorption at low relative humidities, which adversely impacts on electrical properties. DSP plates are a good insulating, low dielectric material as long as it is kept dry. Hydration under autoclaving conditions may be a way of solving the problem and hydration chemistry at various temperatures have been studied. The Center has also studied a magnesium triphosphate cement, as a precursor to polyphosphate cements and is exploring inorganic-polymer composites at the molecular levels. Finally the Center has investigated the influence of packing and particle interactions on the rheology of suspensions with high solids contents. The Center also established and maintains a facility for the characterization of powders and porous materials.

41060 (AD-A–220142/4/XAB) **Dynamics of microphases separation during RIM copolymerization: Some synchrotron SAXS experiments. Technical report.** Connecticut Univ., Storrs, CT (USA). Inst. of Materials Science. 27 Mar 1990. 5p. (TR–6). Available from NTIS, PC A01/MF A01.

Using the high x-ray flux afforded by a synchrotron radiation source, the formation of the polyurethane morphology during fast polymerization by reaction injection molding (RIM) was observed as a function of mold temperature through small angle x-ray scattering measurements. To our knowledge, this represents the first time that the development and growth of microphase separation during the polyurethane RIM process has been reported.

41061 (AD-A–220160/6/XAB) **Compression-molded polyurethane block copolymers. 3. Evaluation of microphase compositions. Technical report.** Koberstein, J.T.; Leung, L.M. Connecticut Univ., Storrs, CT (USA). 27 Mar 1990. 38p. (TR–6). Available from NTIS, PC A03/MF A01.

See also 1, AD-A220 068.

This paper presents methods to estimate the microphase compositions in polyurethane segmented block copolymers based upon combined analyses by small-angle x-ray scattering and differential scanning calorimetry. The methods are applied to a system of polyurethanes prepared from 4,4'-diphenylmethane diisocyanate, 1,4-butanediol, and a 2000 MW ethylene glycol capped polypropylene oxide prepolymer. The resultant microphase compositions predict microphase transition temperatures that compare well with observed values. The versatile mechanical properties of segmented polyurethane elastomers are generally attributed to the formation of a microphase separated structure due to incompatibility of the glassy hard segment and rubbery soft segment sequences. From these results, it appears that the morphological behavior of polyurethanes is strongly dependent on polydispersity. In monodisperse model compounds, extend chains are predominant, while in normal segmented polyurethanes, the evidence supports the occurrence of some type of hard segment chain folding or reentry into the hard microdomain.

41062 (AD-A–220209/1/XAB) **Quantitative microstructural analysis of unidirectional carbon-fiber-reinforced polymer composites. Part 1. Microstructural characterization of composite cross section. Final report.** Ricca, J.J.; Jurta, R.M. Army Materials Research Agency, Watertown, MA (USA). Materials Technology Lab. Jan 1990. 40p. (MTL-TR–90-1). Available from NTIS, PC A03/MF A01.

Individual axial tensile specimens of AS4/3501-6 and T300/934 unidirectional carbon fiber reinforced polymer composite laminate systems are characterized microstructurally. Fiber volume, fractional fiber volume, fiber uniformity, void volume, and variations in laminate thickness are acquired using automated quantitative image analysis (QIA). The sample preparation methods and QIA system procedures are fully explained. The problems in determining average or batch fiber contents in composite laminates using current methods are discussed. Possible problems in using micrometer thickness data in fiber content calculations are discussed when variations in specimen thickness due to surface contours are present. Variations in microstructure exhibited within a single fabricating company, between several fabricating companies, and between two different fiber-resin systems are demonstrated. Overall, QIA was determined to be a precise means of determining fiber and void contents and uniformity in individual test specimens prior to or after mechanical testing.

41063 (AD-A–220229/9/XAB) **Ion implantation in III-V semiconductors.** Donnelly, J.P. Massachusetts Inst. of Tech., Lexington, MA (USA). Lincoln Lab. 1989. 98p. (JA–5592). Available from NTIS, PC A05/MF A01.

Pub. in III-V Semiconductor Materials and Devices, 331-428(1989).

Ion implantation in the III-V compound semiconductors is of considerable importance because of its applicability to a wide variety of high-speed electronic and optoelectronic devices and integrated circuits. In this chapter the important parameters that affect implantation results in these materials are discussed. They include ion mass, energy and dose, implant temperature, stoichiometry, the post-implantation anneal procedure, diffusion of the implanted species and deleterious substrate effects. An overall review of the

current state of the art in producing n-type, p-type and high resistivity layers in Gallium Arsenide, Indium Phosphide and related III-V compounds is then presented. The chapter concludes with a synopsis of the most important applications of this technology.

41064 (AD-A–220265/3/XAB) **CVD diamond films for tribological applications. Final report.** Piano, L.S.; Hayward, I.; Wegand, J. Crystallume, Menlo Park, CA (USA). 31 Mar 1990. 46p. Available from NTIS, PC A03/MF A01.

Friction and wear behavior of several types of diamond film has been studied using sapphire on diamond film and diamond on diamond film tests. The coefficient of friction of the films was found to be a strong function of film morphology for sapphire on diamond film tests, and of diamond bonding content for diamond on diamond film tests. Smooth films were found to have coefficients of friction approaching the lower value for natural diamond (0.05), regardless of bonding composition. Films were deposited in three groups. Film morphology and graphite content were varied in the first group. In the second group, increased growth rates of highly diamond-bonded material were sought. Smooth, very fine grained material of varied bonding content was produced in the third. Attempts at surface planarization through etching and regrowth were not successful. All films were found to have excellent adhesion to both silicon and silicon carbide substrates. This study indicates that CVD diamond films have excellent potential for use as solid-film bearings, and that this potential merits further work.

41065 (AD-A–220849/4/XAB) **Sol-gel processing and crystallization of yttrium aluminosilicates. Final report.** Walck, J.C.; Pantano, C.G. Army Materials Research Agency, Watertown, MA (USA). Materials Technology Lab. Mar 1990. 20p. (MTL-TR–90-10). Available from NTIS, PC A03/MF A01.

Glasses in the yttria-aluminum-silica (YAS) system are candidate matrices for SiC reinforced composites because of their high elastic moduli and excellent chemical durability. Moreover, several compositions offer the potential for controlled crystallization into glass ceramics exhibiting low-thermal expansion and elevated temperature stability. In order to exploit the properties of these glasses and glass ceramics, improved processing techniques and detailed investigations of their crystallization behavior are required. Glass in the yttria-alumina-silica system was synthesized using sol-gel techniques. Crystallization behavior of the gel and the glass was examined using variable heating rate data obtained by differential thermal analysis (DTA). The reaction rate constants for crystallization followed an Arrhenius temperature dependence, and the activation energies for crystallization were readily determined. Surface nucleation/crystallization dominated but no appreciable difference in crystallization between the gel and glass powders was evident. In this system it was verified that densification of the gel occurred before the onset of crystallization. Isothermal heat treatment of the gels and glasses produced $3Al_2O_3$-$2SiO_2$ and various polymorphs of Y_2O_3.$2SiO_2$. Yttrium pyrosilicates, Mullite.

41066 (ALS/TR–89-035) **"Twisted" crystals: Propagation, genesis, and relationships with optical activity and molecular symmetry (excerpts).** Bernauer, F. Sandia National Labs., Albuquerque, NM (USA). 21 Nov 1989. 47p. Translated from Forschungen zur Kristallkunde; 2: pp. 1-7, 57-77(1929). Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. Order Number DE90014259. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

With respect to the screw-like "twisting" of many crystals, Wallerant has already supposed that twisting is related to a "structure dissymetrique" of the crystals. In accordance with Pasteur's law, such bodies will in general crystallize in enantiomorphic forms and possess at least the possibility of optical activity. In a few cases, Wallerant has observed a direct relationship between the sense of optical rotation of the substance and the twisting direction of the crystals. The author's own research has dealt only with substances that the literature identifies as possessing holohedric symmetry, lacking optical rotatory power, but nonetheless exhibiting twisted forms. At the same time, it was found that the presence of foreign impurities did not just influence the twisting but was its sole cause in many cases. An obvious further step was to relate the screw-shaped deformation of crystals with the far more frequently observed simple curvature; finally, an attempt was made to elucidate the mechanism of curvature or twisting.

41067 (CONF-900419–6) **Temperature and concentration dependence of SiC deposition on Nicalon fibers.** Besmann, T.M.; Sheldon, B.W.; Kaster, M.D. Oak Ridge National Lab., TN (USA). [1990]. 16p. Sponsored by U.S. Department of Defense. DOE Contract AC05-84OR21400. Contract FY1457-89-N5001. From 8. international triennial conference on thin films and the 17th international conference on metallurgical coatings; San Diego, CA (USA); 1-6 Apr 1990. Order Number DE90014214. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Chemical vapor infiltration of Nicalon™ fiber bundles (~500 filaments) was studied using methltrichlorosilane to form the SiC matrix. The operating conditions were chosen to simulate those used in composite fabrication. It was determined that the deposition reaction has an activation energy of 66 (± 20) kJ/mol and is first order with respect to reactant concentration. 17 refs., 4 figs., 1 tab.

41068 (CONF-900731–1) **Mechanical properties testing of diamond and diamond-like films by ultra-low load indentation.** O'Hern, M.E. (Tennessee Univ., Knoxville, TN (USA)); McHargue, C.J. Oak Ridge National Lab., TN (USA). [1990]. 8p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. From NATO Advisory Study Institute on diamond and diamond-like films; Castelvecchio Pascoli (Italy); 22 Jul - 2 aug 1990. Order Number DE90014456. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The mechanical properties of diamond-like carbon and diamond films have been studied using an ultra-low load indentation technique. The elastic/plastic properties of the films can be evaluated from the continuous load and displacement data acquired with a mechanical properties microprobe. Values for hardness and elastic modulus are given for both types of films relative to natural diamond and single-crystal sapphire. Determination of hardness and modulus of elasticity in thin films (particularly those with high values such as diamond) requires more information than can be obtained from conventional (e.g., Knoop or Vicker's) microhardness testing. The use of the mechanical properties microprobe to characterize these properties is addressed. 6 refs., 4 figs.

41069 (CONF-9006227–1) **A study of the elastic properties of Al_2O_3 and Si_3N_4 matrix composites with SiC whisker reinforcement.** Fisher, E.S. (Hawaii Univ., Honolulu, HI (USA). Hawaii Inst. of Geophysics); Manghnani, M.H.; Routbort, J.L. Argonne National Lab., IL (USA). May 1990. 11p. Sponsored by U.S. DOE Energy Research. DOE Contract W-31109-ENG-38. From TMS symposium on high performance composites for the 1990's; Morristown, NJ (USA); 6-8 Jun 1990. Order Number DE90013674. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

A study of the elastic moduli of Al_2O_3 and Si_3N_4 ceramics reinforced with 0-25 wt % SiC whiskers has been carried out. The Young's and shear moduli for each composite sample are compared with upper and lower bounds as calculated from the elastic moduli of the constituents using Paul's model. The moduli for the Al_2O_3 based composites are generally lower than the calculated lower bounds whereas the values for the Si_3N_4 based composites are in agreement with the average between the upper and lower bounds. These results are interpreted as reflecting the relatively poor Al_2O_3/SiC interface bond, which allows for the observed whisker pullout in these samples, and the relatively strong interface bond in the Si_3N_4 composites. 26 refs., 2 figs.

41070 (CONF-9009147–1) **Micromechanics analysis of powder consolidation in manufacturing particulate-reinforced MMCs [metal matrix composites].** Tszeng, T.C. Oak Ridge National Lab., TN (USA). [1990]. 9p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. From International conference on fabrication of particulates reinforced metal composites; Montreal (Canada); 16-19 Sep 1990. Order Number DE90014448. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

A micromechanics study of the interaction between reinforcing particulate and matrix powder particles subjected to isostatic pressing has been carried out. The model enables us to examine the deformation, number of contacting particles, total contact area, and

average contact pressure on an individual particulate or powder particle. Three different powder systems were analyzed. Particularly, the composite powder systems are typified by a dual-sized powder system consisting of 20 wt % reinforcing particulate and 80 wt % matrix particles of 1/2.6 size ratio. The analysis shows that the smaller reinforcing particulates experience larger specific contact area and higher average contact pressure in comparison with the larger matrix powder particles. 18 refs., 11 figs.

41071 (CRIE-W–89020) **Survey on application of power electronics.** Izumi, K.; Ito, H.; Sekiguchi, K.; Ito, T.; Watanabe, Y. Central Research Inst. of Electric Power Industry, Tokyo (Japan). Nov 1989. 61p. (In Japanese). Order Number DE90507842. Available from NTIS (US Sales Only), PC A04/MF A01.

In this report, the survey on the present status of the power electronic technologies was conducted in order to extract the problems on wide application of the technologies. For the progress of power semiconductor devices, the development of thyristors which can be directly ignited photo signal, large capacity GTO thyristors and new high speed devices such as IGBT, is remarkable. For the application, it is confirmed that the power controllers and converters with electron tubes, rotating machines and so on, are replaced by ones with semiconductor devices on the fields except for high frequency generators and protective switches. The authors concludes that in order to emphasize the power electronics application in electric power utilities, the reduction of cost, loss, harmonics and audible noise is needed, and more refinement of devices and conversion is important. They also concludes that the development of new materials such as GaAs is important. 53 refs., 34 figs., 19 tabs.

41072 (DOE/ER/00038–3300) **Basic vacuum technology for junior glassblowers.** Duncanson, I.B. Notre Dame Univ., IN (USA). [1990]. 38p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76ER00038. (CONF-9006231–2: ASGS '90: American scientific glassblowers society conference, Orlando, FL (USA), 25-29 Jun 1990). Order Number DE90014139. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This paper used in conjunction with classroom discussion is intended to provide the junior scientific glassblower with a fundamental understanding of the terminology and tools relative to high vacuum generation, measurement, and maintenance in the laboratory. Topics covered include vacuum gauges, mechanical vacuum pumps, diffusion pumps, vacuum system design, and elementary leak detection. 6 refs.

41073 (EOARD-LR–89-050) **Third European Conference on Composite Materials.** Dymek, C.J. Jr.; Hansen, J.G.R. European Organization for Nuclear Research, Geneva (Switzerland). 1989. 19p. Available from NTIS, PC A03/MF A01.

The Third European Conference on Composite Materials was held in Bordeaux, France from 20 to 23 March 1989. In terms of research reported, there was nearly equal representation from academia on the one hand and industry and government labs on the other. The subjects of the technical presentations were about equally divided among polymer, ceramic and metal matrix composites. Areas receiving the greatest emphasis were SiC and carbon-containing composites, fiber structure and coatings, thermosets and thermoplastics, and laminate mechanics.

41074 (JAERI-M–90-010) **Study on radiation-induced deterioration of grease at high temperature, 1: Test method on thermal aging.** Soda, Takao (Matsumura Oil Research Corp., Nishinomiya, Hyogo (Japan)); Nakanishi, Hiroshi; Akada, Tamio; Hirohama, Mitsuo; Yagi, Tetsuya; Arakawa, Kazuo; Sasuga, Tsuneo; Hagiwara, Miyuki; Seguchi, Tadao. Japan Atomic Energy Research Inst., Tokyo (Japan). Feb 1990. 28p. (In Japanese). Order Number DE90508070. Available from NTIS (US Sales Only), PC A03/MF A01.

As a series of the studies on radiation-induced deterioration of grease at high temperature, this report presents a test method of thermal aging of greases which can be applied to the test of greases under the γ-irradiation at elevated temperatures. The grease properties (penetration, free acid, oil separation) are affected by an amount of base oil evaporated from the grease at high temperature. The base oil evaporation depends on depth of a vessel and thickness of the greases in the vessel for test. As results of the investigation of the evaporation of oil in relation to the shape the vessel and the thickness of the grease, the amount of evaporated oil when 17 mm deep glass vessel and 6 mm thick grease was equivalent to that observed by a test conducted using a JIS K-2220, B method. It was found that the sample vessel need to be put on the lid when the several kinds of grease samples are heated in the same oven at same time. (author).

41075 (JAERI-M–90-011) **Radiation resistance of radiation shield rubber.** Kasai, Akio (Showa Rubber Co. Ltd., Tokyo (Japan)); Yamaguchi, Norio; Watanabe, Tadashi; Seguchi, Tadao; Nishii, Masanobu. Japan Atomic Energy Research Inst., Tokyo (Japan). Feb 1990. 67p. (In Japanese). Order Number DE90508040. Available from NTIS (US Sales Only), PC A04/MF A01.

The radiation shield rubber of ethylene-propylene copolymer (EPDM) and of chlorinated polyethylene (CM) mixed with a large amount of powder or foil lead were irradiated under vacuum or in oxygen atmosphere by Co-60 gamma rays for an evaluation of the radiation resistance. The changes of mechanical properties, thermal characteristics, gel-fraction and swelling ratio, and gas evolution and oxygen consumption against dose were measured for both rubber materials. The radiation resistance and the degradation mechanisms were discussed. The tensile strength and the elongation at break of EPDM and CM decreased with the amount of lead mixed into the polymers. The radiation resistance of EPDM with lead was only 1/4 - 1/5 of that of EPDM without lead when the both materials were irradiated in oxygen or under vacuum. For CM, the radiation resistance showed the similar behavior as EPDM. And also the radiation resistance was found to be depending on the shape of lead, that is, the foil lead is more effective to degradation than the fine powder lead. It is supposed that the decrease of radiation resistance by addition of lead are caused by the increase of absorbed dose, because the radiation energy absorbed in lead is transferred to the rubber. For the evaluation of life time of these rubber materials in the radiation environment, the degradation was investigated by the radiation and thermal sequential combined aging. The rate of thermal degradation was much accelerated with dose of the previous irradiation. The life time was estimated by applying Arrhenius plots of thermal degradation rate and the acceleration factor by irradiation. In order to improve the radiation resistance, the effects of Con-BACN compound as anti-rad and fire retardant agent were studied, and it is found that the radiation resistance was improved about twice. (author).

41076 (Juel–2330) **Thermomechanical loading of thin oxide coatings. Damage behaviour and hydrogen-permeation.** Marewski, U. Kernforschungsanlage Juelich GmbH (Germany, F.R.). Inst. fuer Reaktorentwicklung; Technische Hochschule Aachen (Germany, F.R.). Dec 1989. 120p. (In German). Order Number DE90510258. Available from NTIS (US Sales Only), PC A06/MF A01.

For an optimal selection of structural materials in practical applications it is important to obtain a detailed knowledge of the mechanical load of the system. Therefore in the first part of this paper several theoretical models - based on a special oxide/metallic substrate system (Cr_2O_3/2.4665) - are derived. These models describe the mechanical loading of the layer and are compared with experimental investigations. The experimental results concerning the state of mechanical stress in the coatings, which are determined by mechanical testing as well as by X-ray stress evaluation, are in good agreement with theoretical predictions. In the second part it is examined the relation between the damage behaviour of such layer/substrate arrangements and hydrogen permeation measurements. The hydrogen permeation signals are a highly sensitiv probe to detect layer defects and it is even possible to describe the quantitative damage behaviour of the oxide scales. (orig.).

41077 (LBL–29035) **Microtomy of large particle zeolites for TEM.** Ulan, J.G.; Schooley, C.; Gronsky, R. Lawrence Berkeley Lab., CA (USA). Apr 1990. 6p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00098. (CONF-900466–73: Spring meeting of the Materials Research Society, San Francisco, CA (USA), 16-21 Apr 1990). Order Number DE90014182. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Uniformly thin specimens of powders, suitable for electron microscopy, can be prepared by ultramicrotomy. There is a size limit to the particles that can be studied since larger particles tend to be dislodged from the available resins when microtomed. A method is described to strengthen the binding of the organic resin to the inorganic zeolite, allowing large particles to be sectioned. The particle size limit increased from 3 μm to greater than 20 μm in diameter for FeZSM-5 aggregates. This method can be applied to a variety of oxide powder samples, extending the utility of microtomy as a materials science tool. 5 refs., 3 figs.

41078 (MLM–3641(OP)) **Thermogravimetry-mass spectrometry analysis of gas bubbles in molten glass.** Chang, C.; Tackett, J.R.; Coleman, K.C. EG and G Mound Applied Technologies, Miamisburg, OH (USA). [1990]. 3p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-88DP43495. (CONF-9006241–3: 38. ASMS conference on mass spectrometry and allied topics, Tucson, AZ (USA), 4-8 Jun 1990). Order Number DE90014116. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Short communication. GLASS/fabrication; STAINLESS STEELS/bonding; MASS SPECTROMETERS/measuring methods; VACUUM SYSTEMS/connectors; CONNECTORS/fabrication; GLASS; FABRICATION; BONDING; BUBBLES; GASES; CONNECTORS; CHROMATOGRAPHY; THERMAL GRAVIMETRIC ANALYSIS; SUPERCONDUCTIVITY; VERY HIGH TEMPERATURE; SODIUM COMPOUNDS; POTASSIUM COMPOUNDS; ELECTRICAL INSULATORS; ELECTRIC CONDUCTORS

41079 (N–90-20138) **Composite laminate tailoring with probabilistic constraints and loads.** Thanedar, P.B.; Chamis, C.C. National Aeronautics and Space Administration, Cleveland, OH (USA). Lewis Research Center. 1990. 18p. (NASA-TM–102515;E–5182;NAS–1.15:102515;CONF-900102–: 13. energy-sources technology conference and exhibition, New Orleans, LA (USA), 14-18 Jan 1990). Available from NTIS, PC A03/MF A01.

A reliability-based structural synthesis procedure was developed to tailor laminates to meet reliability-based (ply) strength requirements and achieve desirable laminate responses. The main thrust is to demonstrate how to integrate the optimization technique in the composite laminate tailoring process to meet reliability design requirements. The question of reliability arises in fiber composite analysis and design because of the inherent scatter that is observed in the constituent (fiber and matrix) material properties during experimentation. Symmetric and asymmetric composite laminates subject to mechanical loadings are considered as application examples. These application examples illustrate the effectiveness and ease with which reliability considerations can be integrated in the design optimization model for composite laminate tailoring.

41080 (N–90-20139) **Evaluation of thermal and mechanical loading effects on the structural behavior of a SiC/titanium composite.** Grady, J.E.; Lerch, B.A. National Aeronautics and Space Administration, Cleveland, OH (USA). Lewis Research Center. Apr 1990. 15p. (NASA-TM–102536;E–5349;NAS–1.15:102536;CONF-9004212–: 31. AIAA/ASME/ASCE/AHS/ASC structures, structural dynamics and materials conference, Long Beach, CA (USA), 2-4 Apr 1990). Available from NTIS, PC A03/MF A01.

Composite specimens of titanium-15-3 matrix reinforced with continuous SCS-6 silicon carbide fibers were tested under a variety of thermal and mechanical loadings. A combined experimental/finite element approach was used to estimate the effective in-situ modulus of the matrix material and to evaluate changes in modulus due to the applied loads. Several fiber orientations were tested. Results indicate that the effect of the thermal loads on composite stiffness varies with fiber orientation. Applications of this method to test specimens damaged by uniaxial tension, thermal cycling, and isothermal fatigue loadings are used to illustrate that by monitoring overall structural behavior, changes in stiffness caused by thermomechanical loading can be detected.

41081 (N–90-20151) **Fundamental aspects of and failure modes in high-temperature composites.** Chamis, C.C.; Ginty, C.A. National Aeronautics and Space Administration, Cleveland, OH (USA). Lewis Research Center. 1990. 16p. (NASA-TM–102558;E–5378;NAS–1.15:102558;CONF-900439–: 35. international symposium and exhibition of the Society for the Advancement of Material and Process Engineers: advanced materials: the challenge for the next decade, Anaheim, CA (USA), 2-5 Apr 199 Available from NTIS, PC A03/MF A01.

Fundamental aspects of and attendant failure mechanisms for high temperature composites are summarized. These include: (1) in-situ matrix behavior; (2) load transfer; (3) limits on matrix ductility to survive a given number of cyclic loadings; (4) fundamental parameters which govern thermal stresses; (5) vibration stresses; and (6) impact resistance. The resulting guidelines are presented in terms of simple equations which are suitable for the preliminary assessment of the merits of a particular high temperature composite in a specific application.

41082 (N–90-20886) **Millimeter wave surface resistance of $RBa_2Cu_3O_{7-\delta}$ (R = Y, Eu, Dy, Sm, Er) superconductors.** Miranda, F.A.; Gordon, W.L.; Eck, T.G.; Bhasin, K.B.; Warner, J.D.; Jenkins, K.A. National Aeronautics and Space Administration, Cleveland, OH (USA). Lewis Research Center. 1990. 9p. (NASA-TM–102571;E–5395;NAS–1.15:102571;CONF-900384–: American Physical Society meeting, Anaheim, CA (USA), 12-16 Mar 1990). Available from NTIS, PC A02/MF A01.

The measurements are reported of the millimeter wave surface resistance R(sub s) at 58.6 GHz of bulk samples of RBa_2Cu_3O(7-delta) (R = Y,Eu,Dy,Sm,Er) and of YBa_2Cu_3O(7-delta) superconducting films, in the temperature range from 20 to 300 K. The bulk samples were prepared by cold pressing the powders of RBa_2Cu_3O(7-delta) into one in. disks. The powders were prepared by several sinterings in one atmosphere of oxygen at 925 C, with grindings between sinterings, to obtain the superconducting phase. The thin films were deposited on $SrTiO_3$ and $LaGaO_3$ substrates by pulsed laser ablation. Each sample was measured by replacing the end wall of a gold-plated Te_{013} circular mode copper cavity with the sample and determining the cavity quality factor . From the difference in the Q-factor of the cavity, with and without the sample, the R_s of the sample was determined.

41083 (N–90-21124) **Use of unbalanced laminates as a screening method for microcracking.** Papadopoulos, D.S.; Bowles, K.J. National Aeronautics and Space Administration, Cleveland, OH (USA). Lewis Research Center. 1990. 17p. (NASA-TM–102517;E–5214;NAS–1.15:102517;CONF-900439–: 35. international symposium and exhibition of the Society for the Advancement of Material and Process Engineers: advanced materials: the challenge for the next decade, Anaheim, CA (USA), 2-5 Apr 199 Available from NTIS, PC A03/MF A01.

State-of-the-art, high temperature polyimide matrix composites, reinforced with continuous graphite fibers are known to be susceptible to intraply cracking when thermally cycled over their useful service temperature range. It is believed that the transply cracking, in part, results from residual stresses caused by differences in coefficients of thermal expansion (CTE) between the polymer matrix and the reinforcement. Thermal cycling tests to investigate this phenomenon involve expensive time and energy consuming programs which are not economically feasible for use as a part of a materials screening process. As an alternative to thermal cycling studies, a study of unbalanced crossply graphite fiber reinforcement composites was conducted to assess the effect of the composite ply layup and surface condition on the residual stresses that remain after the processing of these materials. The residual stresses were assessed by measuring the radii of curvature of the types of laminates that were studied. The temperature at which stress-free conditions existed were determined and a dye penetrant method was used to observe surface damage resulting from excessive residual stress buildup. These results are compared with some published results of thermal cycling tests that were previously conducted on balanced polyimide composites.

41084 (N–90-21140) **Micromechanics analysis of space simulated thermal deformations and stresses in continuous fiber reinforced composites.** Bowles, D. E. National Aeronautics and Space Administration, Hampton, VA (USA). Langley Research Center. Mar 1990. 119p. (NASA-TM–102633;NAS–1.15:102633). Available from NTIS, PC A06/MF A01.

Space simulated thermally induced deformations and stresses in continuous fiber reinforced composites were investigated with a micromechanics analysis. The investigation focused on two primary areas. First, available explicit expressions for predicting the effective coefficients of thermal expansion (CTEs) for a composite were compared with each other, and with a finite element (FE) analysis, developed specifically for this study. Analytical comparisons were made for a wide range of fiber/matrix systems, and predicted values were compared with experimental data. The second area of investigation focused on the determination of thermally induced stress fields in the individual constituents. Stresses predicted from the FE analysis were compared to those predicted from a closed-form solution to the composite cylinder (CC) model, for two carbon fiber/epoxy composites. A global-local formulation, combining laminated plate theory and FE analysis, was used to determine the stresses in multidirectional laminates. Thermally induced damage initiation predictions were also made.

41085 (N–90-21143) **Optimal fabrication processes for unidirectional metal-matrix composites: A computational simulation.** Saravanos, D.A.; Murthy, P.L.N.; Morel, M. National Aeronautics and Space Administration, Cleveland, OH (USA). Lewis Research Center. 1990. 19p. (NASA-TM–102559;E–5379;NAS–1.15:102559;CONF-900439–: 35. international symposium and exhibition of the Society for the Advancement of Material and Process Engineers: advanced materials: the challenge for the next decade, Anaheim, CA (USA), 2-5 Apr 199 Available from NTIS, PC A03/MF A01.

A method is proposed for optimizing the fabrication process of unidirectional metal matrix composites. The temperature and pressure histories are optimized such that the residual microstresses of the composite at the end of the fabrication process are minimized and the material integrity throughout the process is ensured. The response of the composite during the fabrication is simulated based on a nonlinear micromechanics theory. The optimal fabrication problem is formulated and solved with non-linear programming. Application cases regarding the optimization of the fabrication cool-down phases of unidirectional ultra-high modulus graphite/copper and silicon carbide/titanium composites are presented.

41086 (N–90-21409) **Fatigue damage growth mechanisms in continuous fiber reinforced titanium matrix composites.** Johnson, W.S.; Naik, R.A.; Pollock, W.D. National Aeronautics and Space Administration, Hampton, VA (USA). Langley Research Center. Jan 1990. 12p. (NASA-TM–102594;NAS–1.15:102594;CONF-900764–: Fatigue '90 international conference, Honolulu, HI (USA), 15-20 Jul 1990). Available from NTIS, PC A03/MF A01.

The role of fiber/matrix interface strength, residual thermal stresses, and fiber and matrix properties on fatigue damage accumulation in continuous fiber metal matrix composites (MMC) is discussed. Results from titanium matrix silicon carbide fiber composites is the primary topic of discussion. Results were obtained from both notched and unnotched specimens at room and elevated temperatures. The stress in the 0 deg fibers was identified as the controlling factor in fatigue life. Fatigue of the notched specimens indicated that cracks can grow in the matrix materials without breaking fibers.

41087 (ORNL/FTR–3684) **[International discussion meeting on relaxations in complex systems]: Foreign trip report, June 22, 1990–July 1, 1990.** Bates, J.B. Oak Ridge National Lab., TN (USA). 16 Jul 1990. 11p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE90014312. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Relaxation implies the time-dependent change in one or more properties of a material that usually occurs when a mechanical or electrical stress is removed. Of particular interest to the traveler are the relaxation processes in solid ionic conductors that are due to the combined effect of mobile and bound charges. These are the processes that are observed from small signal ac electrical measurements at frequencies from 0.01 Hz to 100 MHz. The central issue is the origin of the non-Debye relaxation processes that are characteristic of conducting systems.

41088 (PB–90-220708/XAB) **Pulse energy fabrication of surface composites. Phase 1. Final report.** Wang, R. Photon Sciences, Inc., Bothell, WA (USA). Sep 1987. 26p. Available from NTIS, PC A03/MF A01.

The research demonstrated a novel and cost-effective method, designated as a pulse melting/quenching (PMQ) process, using high-energy electromagnetic pulses for fabrication of metal-matrix surface composites. Phase I research was to explore material interaction with the electromagnetic pulses and demonstrate PMQ process feasibility based on a state-of-the-art 30 KW, 27 MHz induction unit using short 0.1 to 10 milliseconds (ms) pulses. Experimental results indicated that bonding of foils, surface alloying, and densification of porous coatings were successfully made in 1 to 10 ms pulses. Quench rate was on the order of one thousand to ten thousand K/s, depending on the pulse duration and materials. The heat affected zone ws 2-3 mm wide and up to 0.1 mm deep. Several layers of thin metallic glass foils were bonded to form a 150 micrometer thick single overlay. Thin surface alloyed layers up to 20 micrometers thick were formed by a single pulse. A 120 micrometer thick plasma sprayed metallic glass coating was nearly 100% densified by a 5 ms pulse.

41089 (PB–90-868753/XAB) **Boron-fiber-reinforced plastics. January 1973-February 1990 (A Bibliography from the Rubber and Plastics Research Association data base). Report for January 73-February 1990.** National Technical Information Service, Springfield, VA (USA). May 1990. 113p. Available from NTISPC N01/MF N01.

Supersedes PB–83-861070.

This bibliography contains citations concerning the applications, molding processes, properties, design concepts, and market trends of polyester and epoxy resins reinforced with boron fibers. Performance evaluations from nondestructive test results are also included. (This updated bibliography contains 249 citations, 110 of which are new entries to the previous edition.)

41090 (PB–90-868795/XAB) **Silicone resins: Chemistry. January 1977-February 1990 (A Bibliography from the NTIS data base). Report for January 1977-February 1990.** National Technical Information Service, Springfield, VA (USA). May 1990. 114p. Available from NTISPC N01/MF N01.

Supersedes PB–89-855175.

This bibliography contains citations concerning the synthesis, polymerization, and chemical reactions of silicone and silicon-containing polymers and copolymers. Grafting and crosslinking reactions, radiation polymerization, and spectra and molecular structure relative to silicone resin properties are included. (This updated bibliography contains 188 citations, 26 of which are new entries to the previous edition.)

41091 (PB–90-872367/XAB) **Polyester and epoxy resins: Abrasion resistance. January 1977-April 1990 (A Bibliography from the Rubber and Plastics Research Association data base). Report for January 1977-April 1990.** National Technical Information Service, Springfield, VA (USA). Jun 1990. 166p. Available from NTISPC N01/MF N01.

Supersedes PB–87-855466.

This bibliography contains citations concerning test procedures and results, compounds and additives, forming processes, reinforcement effects, and applications relative to the wear and abrasion resistance of polyester and epoxy resins. Electrical insulation, linings and coatings for numerous substrates, solar control film glazing material, hoses, material to rebuild worn metal parts, pipes, boats, industrial floor coverings, and ladder rungs are among the applications discussed. Trade name materials and manufacturers are included. (This updated bibliography contains 334 citations, 62 of which are new entries to the previous edition.)

41092 (SAND–90-0950) **Radiation and hydrogen in glass: Part 1, The effects of ionizing radiation on silica and borosilicate glasses in the absence of hydrogen.** Phifer, C.C. Sandia National Labs., Albuquerque, NM (USA). Mar 1990. 26p. Sponsored by U.S. DOE Energy Research. DOE Contract AC04-76DP00789. Order Number DE90013612. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The effects of ionizing radiation (e.g., beams of electrons of γ-radiation) on silica and borosilicate glasses are summarized in this review article. In Part 1, irradiation in the absence of hydrogen is considered. The combined effects of hydrogen and irradiation are treated in Part 2. Descriptions and, if available, mechanisms of changes in the glass properties are discussed. Several experimental variables which may affect the outcome of an irradiation procedure are also outlined. 47 refs.

41093 (SAND–90-0951) **Radiation and hydrogen in glass: Part 2, The properties of hydrogen in unirradiated and irradiated silica and borosilicate glasses.** Phifer, C.C.; Keefer, K.D. Sandia National Labs., Albuquerque, NM (USA). Mar 1990. 13p. Sponsored by U.S. DOE Energy Research. DOE Contract AC04-76DP00789. Order Number DE90013613. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Part 1 of this review deals with the effects of ionizing radiation on glass in the absence of hydrogen and should be consulted for background information not repeated in Part 2. This part includes information on the behavior of hydrogen in glass and how it is affected by experimental variables such as temperature, pressure, and glass composition. The reaction of hydrogen with irradiated glass is treated next, and finally the effects of ionizing radiation on hydrogen-impregnated glass are summarized. 51 refs., 1 tab.

41094 (UCID–20839-87-4) **Abrasion and impact resistant coatings.** Steele, W.A.; Mohr, P.B.; Leider, H.R. Lawrence Livermore National Lab., CA (USA). 31 Dec 1987. 3p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. Order Number DE90014731. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Abrasion and impact resistance are a prime requirement for many materials applications. To best protect plastic or metal-based composites from abrasion and impact, a surface coating that is simultaneously very hard and highly yielding is necessary. Both these requirements can be met by a dense pattern of emergent fibers or high L/D ratios, well rooted but with one end free, i.e., hair. A covering of such hair, with fibers long enough to accommodate themselves to impacting objects, will give substantial protection against impact or particle abrasion. 1 tab.

41095 Electron transfer at the semiconductor/liquid interface. Forbes, M.D.E. (California Institute of Technology, Pasadena (USA)); Ryba, G.N.; Lewis, N.S.; Feldberg, S.W. pp. 97 of American Chemical Society, Division of Colloid and Surface Chemistry. American Chemical Society, Washington, DC (US) (1990). (CONF-900402–: 199. national meeting of the American Chemical Society, Boston, MA (USA), 22-27 Apr 1990).

The transient microwave and radio-frequency conductivity techniques have been used to measure carrier lifetimes in Silicon and Gallium Arsenide in the presence of solvent, electrolyte, and redox couple. Variation of the semiconductor surface treatment, solvent, redox potential and concentration, and carrier injection level altered the time profile of the conductivity decays significantly. A finite difference integration technique has been used to model the decays and extract interfacial charge transfer rates. The model includes known parameters for luminescence, bulk and surface trapping, and diffusion. Particular attention has been paid to the effect of space charge potentials near the surface of the semiconductor.

41096 Heteroepitaxy of GaAs on Si and Ge by low-energy ion beams deposition using alternating beams. Haynes, T.E. (Oak Ridge National Lab., TN (USA). Solid State Div.); Zuhr, R.A.; Pennycook, S.J. pp. 311-316 of Advances in materials, processing and devices in III-V compound semiconductors: Volume 144. Sadana, D.K.; Eastman, L.E.; Dupuis, R. Materials Research Society, Pittsburgh, PA (USA) (1989). DOE Contract AC05-84OR21400. (CONF-881155–: Fall meeting of the Materials Research Society, Boston, MA (USA), 28 Nov - 3 dec 1988).

In this paper, the authors demonstrate the growth of heteroepitaxial thin films of GaAs at low temperatures on Si(100) and Ge(100) substrates by direct deposition from controlled, low-energy (30–50 eV), mass-separated beams of $^{69}Ga^+$ and $^{75}As^+$ ions. This represents the first use of two fully ionized beams for the growth of compound semiconductor thin films. Mixing of the constituents was accomplished by periodically switching the analyzing magnet to alternate between deposition of Ga and As at approximately monolayer intervals. Ion channeling and transmission electron microscopy show that GaAs films grown on Ge substrates at 400°C are free of the microtwins and stacking fault defects which emanate from the interface of GaAs similarly grown on Si. Single-crystal GaAs films with ion channeling minimum yields of around 6% have been grown on Ge(100) substrates at temperatures from 520°C down to as low as 320°C.

41097 Energy levels of very short-period $(GaAs)_n$-$(AlAs)_n$ superlattices. Ge, W. (Department of Physics and Astronomy, Dartmouth College, Hanover, NH (USA)); Sturge, M.D.; Schmidt, W.D.; Pfeiffer, L.N.; West, K.W. *Applied Physics Letters (USA)*, 57(1): 55-57 (2 Jul 1990). DOE Contract FG02-87ER45330.

The energy levels of very short-period $(GaAs)_n$-$(AlAs)_n$ superlattices ($n \leq 4$) were investigated by photoluminescence (PL). The results show that these superlattices are type II but the lowest conduction bands are $X_{x,y}$ for $n \leq 3$ and X_z for $n=4$, respectively. (Here X_z is the valley with k parallel to the growth axis.) In both cases the X valleys are very close to each other. PL decay, PL excitation, and PL under uniaxial stress confirm this identification. $Al_{0.5}Ga_{0.5}As$ shows very different behavior, showing that even for $n=1$ our samples are true superlattices.

41098 Electron microscopy of vapor phase deposited diamond. Williams, B.E. (Department of Materials Science and Engineering, North Carolina State University, Raleigh, NC (USA)); Kong, H.S.; Glass, J.T. *Journal of Materials Research (USA)*, 5(4): 801-810 (Apr 1990). DOE Contract AC05-84OR21400 ;AC05-76OR00033.

Thin carbon films grown from a low pressure methane-hydrogen gas mixture by microwave plasma enhanced CVD have been examined by electron microscopy. Previously reported transmission electron microscopy (TEM) of the diamond films[1] has shown that the majority of diamond crystals have a very high defect density comprised of {111} twins, {111} stacking faults, and dislocations. In this study, high resolution electron microscopy (HREM) has been utilized to lattice image individual defects in these polycrystalline diamond films. Interpretation of the images from these defects is not trivial and reported image simulations have been utilized to understand further these defects. Fivefold multiply twinned particles have also been examined and it was found that the 7.5° misfit present in such particles has been accommodated at the twin boundaries rather than by elastic deformation. This creates a twin boundary coincident with a low angle grain boundary which has been termed a "tilted twin boundary." The density of defects in these particles is generally high; however, a dramatic reduction in the defect density near the twin boundaries was observed. This defect reduction is significant because if its origin can be determined, this information may be useful in producing higher quality diamond films.

41099 Optical spectra of localized excess electrons in alkali halide clusters. Rajagopal, G. (School of Physics, Georgia Institute of Technology, Atlanta, Georgia 30332 (USA)); Barnett, R.N.; Nitzan, A.; Landman, U.; Honea, E.C.; Labastie, P.; Homer, M.L.; Whetten, R.L. *Physical Review Letters (USA)*, 64(24): 2933-2936 (11 Jun 1990). DOE Contract FG05-86ER45234.

Excess electrons attached to small alkali halide clusters give rise to optical-absorption bands whose characteristics are highly specific to the mode of electron localization. Optical spectra measured by cluster beam and resonant two-photon ionization spectroscopy agree well with predictions of coupled classical-quantum simulations, and are interpreted in terms of two localization modes: surface F-center and diffuse surface states.

41100 First-principles theory of atomic-scale friction. Zhong, W. (Department of Physics and Astronomy, Michigan State University, East Lansing, MI (USA)); Tomanek, D. *Physical Review Letters (USA)*, 64(25): 3054-3057 (18 Jun 1990). DOE Contract AC03-76SF00098.

We determine the atomic-scale friction associated with a layer of Pd atoms moving across a graphite substrate from *ab initio* total-energy calculations. We evaluate the friction energy caused by variations of the chemical bond strength and work against an external force (load) due to variations of the bond length along the

trajectory. We find only a very small dependence of the Pd-graphite interaction on the adsorption site which gives rise to a very small friction coefficient $\mu \approx 10^{-2}$ for loads near 10^{-8} N. We also find μ to increase with load in agreement with recent experiments.

41101 Carrier scattering by native defects in heavily doped semiconductors. Walukiewicz, W. (Center for Advanced Materials, Lawrence Berkeley Laboratory, 1 Cyclotron Road, Berkeley, CA (USA)). *Physical Review, B: Condensed Matter (USA)*, 41(14): 10218-10220 (15 May 1990). DOE Contract AC03-76SF00098.

Calculations of the effect of charged native defects on carrier mobility in semiconductors are presented. The concentrations of native defects are calculated within the framework of the recently proposed amphoteric-native-defect model. The model provides a simple rule for identification of semiconductor systems in which defect scattering is important. It is shown that native-defect scattering is a dominant mechanism limiting electron mobilities in heavily doped *n*-type GaAs. It is also shown that native defects do not play any significant role in *p*-type GaAs.

41102 Interatomic potentials and the structural properties of silicon dioxide under pressure. Chelikowsky, J.R. (Department of Chemical Engineering and Materials Science, University of Minnesota, Minneapolis, MN (USA)); King, H.E. Jr.; Glinnemann, J. *Physical Review, B: Condensed Matter (USA)*, 41(15): 10866-10869 (15 May 1990). DOE Contract FG02-89ER45391.

First-principles interatomic potentials based on *ab initio* Hartree-Fock self-consistent-field calculations have recently been proposed for silicon dioxide. These pairwise potentials yield accurate ambient-pressure internal-structure parameters and dynamically stable polymorphs for several known forms of silica. We use these potentials to analyze crystallographic data for α-quartz under pressure. We find the potentials do not describe the changes in the internal parameters of α-quartz under pressure. Specifically, the potentials do not give the correct trends for the O-Si-O angles or the c/a lattice-constant ratio. We have included bond-bending terms to modify the pairwise potentials. If the angles in question are fit to reproduce the experimental data, then the bulk modulus is in poor agreement with experiment. Our findings reinforce the need for a "covalent" term in the interatomic potential, which is not based on quadratic expansions of bond-bending and -stretching forces.

41103 Total energy, lattice dynamics, and structural phase transitions in silicon by the orthogonalized linear combination of atomic orbitals method. Zandiehnadem, F. (Department of Physics and Astronomy, University of Kansas, Lawrence, KS (USA)); Ching, W.Y. *Physical Review, B: Condensed Matter (USA)*, 41(17): 12162-12179 (15 Jun 1990). DOE Contract FG02-84ER45170.

We demonstrate the accuracy of the self-consistent orthogonalized linear combination of atomic orbitals method within the local-density approximation by applying it to ten different phases of Si. The electronic properties, total energies, and possible structural phase transitions are studied. Also calculated are the static properties of the diamond-structure Si including the equilibrium lattice constant, bulk modulus, and the pressure derivative of the bulk modulus along with the lattice dynamical properties of a few selective phonons at the zone-center Γ and the edge X points of the Brillouin zone. Furthermore, we have evaluated the internal strain parameter of the diamond-structure Si along the [111] direction. The results of our calculations are in very good agreement with the measured values and the results of the pseudopotential calculations.

41104 Interaction potential for SiO_2: A molecular-dynamics study of structural correlations. Vashishta, P. (Argonne National Laboratory, Argonne, IL (USA)); Kalia, R.K.; Rino, J.P.; Ebbsjoe, I. *Physical Review, B: Condensed Matter (USA)*, 41(17): 12197-12209 (15 Jun 1990). DOE Contract W-31109-ENG-38.

An interaction potential consisting of two-body and three-body covalent interactions is proposed for SiO_2. The interaction potential is used in molecular-dynamics studies of structural and dynamical correlations of crystalline, molten, and vitreous states under various conditions of densities and temperatures. The two-body contribution to the interaction potential consists of steric repulsion due to atomic sizes, Coulomb interactions resulting from charge transfer, and charge-dipole interaction to include the effects of large electronic polarizability of anions. The three-body covalent contributions include O-Si-O and Si-O-Si interactions which are angle dependent and functions of Si-O distance. In lattice-structure calculations with the total potential function, α-cristobalite and α-quartz are found to have the lowest and almost degenerate energies, in agreement with experiments. The energies for β-cristobalite, β-quartz, and keatite are found to be higher than those for α-cristobalite and α-quartz. Molecular-dynamics calculations with this potential function correctly describe the short- and intermediate-range order in molten and vitreous states.

41105 Inverse-photoemission measurement of iron oxides on polycrystalline Fe. Kim, B. (Department of Physics, Iowa State University, Ames, IA (USA)); Hong, S.; Lynch, D.W. *Physical Review, B: Condensed Matter (USA)*, 41(17): 12227-12229 (15 Jun 1990). DOE Contract W-7405-ENG-82.

We measured the inverse-photoemission spectra (IPES) of iron oxides grown on an Fe substrate and calculated the band structure of paramagnetic FeO to analyze the IPES. The band-structure calculation showed some overlap between Fe 3*d* states and O 2*p* states in the region of occupied states, and *s,p*-like states of Fe in the unoccupied region. Isochromatic IPES showed two structures at ~2.5 and ~7.5 eV above the Fermi energy. We estimated from the IPES data a full band gap of 2.5 eV for FeO.

41106 Photoemission and scanning-tunneling-microscopy study of GaSb(100). Franklin, G.E. (Department of Physics, University of Illinois at Urbana-Champaign, 1110 West Green Street, Urbana, IL (USA)); Rich, D.H.; Samsavar, A.; Hirschorn, E.S.; Leibsle, F.M.; Miller, T.; Chiang, T. *Physical Review, B: Condensed Matter (USA)*, 41(18): 12619-12627 (15 Jun 1990). DOE Contract AC02-76ER01198.

Angle-resolved and angle-integrated synchrotron-radiation photoemission together with scanning tunneling microscopy (STM) were used to study the Sb-stabilized GaSb(100)-(1×3) surface grown by molecular-beam epitaxy. Bulk valence bands were mapped out in the Γ-Δ-X direction. The deconvoluted Sb 4*d* and Ga 3*d* core-level line shapes were used to construct a structural model for the surface. STM resolved the individual atomic dimers verifying the proposed model and showed partial disorder inherent on this surface.

41107 Surface geometry of (1×1)PH_x/Ge(111) determined with angle-resolved photoemission extended fine structure. Terminello, L.J. (Department of Chemistry, University of California, Berkeley, Berkeley, CA (USA)); Leung, K.T.; Hussain, Z.; Hayashi, T.; Zhang, X.S.; Shirley, D.A. *Physical Review, B: Condensed Matter (USA)*, 41(18): 12787-12796 (15 Jun 1990). DOE Contract AC03-76SF00098.

Angle-resolved photoemission extended fine structure (ARPEFS) obtained from the phosphorus 1*s* core level was studied to determine the chemisorption geometry of (1×1)PH_x/Ge(111), prepared by partial dissociation of PH_3 adsorbed on Ge(111). We determined that the phosphorus adsorbs 2.26 A above a first-layer germanium atom, and preferentially tilts toward the second-layer germanium atom with a 0.63-A lateral displacement from a true atop position. Other geometrical parameters determined from the multiple-scattering, spherical-wave analysis of the ARPEFS include the first- to second-layer germanium Ge(1)-Ge(2) spacing (0.68 A) and the second- to third-layer germanium Ge(2)-Ge(3) spacing (2.68 A). This represents a 17% contraction for Ge(1)-Ge(2) and a 9% expansion for Ge(2)-Ge(3). The importance of adsorbate scattering and how it affects data interpretation are also discussed. Comparison of this chemisorption system with other systems is made.

41108 First-principles calculations of the three-dimensional structure and intrinsic defects in *trans*-polyacetylene. Vogl, P. (Center for Nonlinear Studies, Los Alamos National Laboratory, Los Alamos, New Mexico 87545 (USA)); Campbell, D.K. *Physical Review, B: Condensed Matter (USA)*, 41(18): 12797-12817 (15 Jun 1990).

We report a first-principles, local-density-functional (LDA) calculation of the electronic structure of crystalline, three-dimensional (3D) *trans*-$(CH)_x$. For the perfect crystal, we find a broken-symmetry ground state having $P2_1/a$ space-group symmetry,

corresponding to *in*-phase dimerization on neighboring chains within the unit cell. We show that in this structure the interchain couplings, although weak, lead to an asymmetry between the valence and conduction bands and, more importantly, give 3D character to the electronic band-edge states. We investigate several additional aspects of the electronic structure of the perfect crystal, including self-consistent optimization of the ions in the unit cell, spin polarization and electronic charge densities, interchain electron-phonon interactions, and the density of states. To study intrinsic defects in *trans*-$(CH)_x$, we map our LDA results onto a multi-orbital, tight-binding model; this mapping preserves very accurately all the electronic-structure properties of the full calculation. Using a Koster-Slater Green-function technique, we are able to examine both (shallow) polaronlike and (deep) bipolaronlike lattice distortions corresponding to localized defects. We find that the 3D character of the electronic band-edge states strongly suppresses the formation of the self-trapped, localized defects characteristic of the 1D models, destabilizing polarons and possibly bipolarons as well in perfectly ordered 3D *trans*-$(CH)_x$. To establish a connection with earlier work, we demonstrate that by artificially decreasing interchain effects and/or increasing the intrachain electron-phonon coupling we can cause polarons and bipolarons to form.

41109 Spectroscopic determination of the distribution of Cr^{3+} sites in mullite ceramics. Liu, H. (Department of Physics and Astronomy, University of Georgia, Athens, Georgia 30602 (USA)); Knutson, R.; Jia, W.; Strauss, E.; Yen, W.M. *Physical Review, B: Condensed Matter (USA)*, 41(18): 12888-12894 (15 Jun 1990). DOE Contract FG09-87ER45291.

Excitation spectra and lifetime measurements were used to distinguish high-field-site (HFS) and low-field-site (LFS) Cr^{3+}-ion behaviors. A theoretical analysis of site distribution gives an adequate fit to the luminescent spectra. The residual content of LFS in the glass ceramic was found to depend on the extent of the heat treatment.

41110 Tin/Al_2O_3/TiAlOn composite. Han, K. To Department of the Interior, Washington, DC. USA Patent Application 7-502,709. 2 Apr 1990. 18p. Available from NTISPC N03/MF A01.

This Government-owned invention available for U.S. licensing and, possibly, for foreign licensing. Copy of application available NTIS.

The present invention pertains to novel improved density ceramic composites of TiN/Al2O3/TiAlON in which there is no spinel and no AlN, but alpha-alumina, titanium nitride, and titanium aluminum oxynitride. In general, the improved density TiN/Al2O3/TiAlON ceramic composites of the invention are prepared by: adding aluminum isobutoxide (Al(O-iBu)3) to a refluxing mixture of deionized water and formic acid at elevated temperatures to obtain an aluminum sol; casting the slurry in molds; drying the cast material and calcining it at about 600 C; screening the calcined material to minus 200 mesh; pressing pellets at about 10 KPsi, isostatically pressing them at about 40 KPsi; and sintering the pellets below 1,700 C to obtain sintered bodies having densities greater than about 4.2 g/cc.

40 CHEMISTRY

4001 Analytical and Separations Chemistry

Refer also to citation(s) 40387, 40395, 40410, 40838, 41051, 41659

41111 (BARC–1481) **Spectroscopy Division progress report for January 1987 - December 1988.** Dixit, R.M. (ed.) (Bhabha Atomic Research Centre, Bombay (India). Spectroscopy Div.). Bhabha Atomic Research Centre, Bombay (India). 1989. 186p. Order Number DE90632836. Available from NTIS (US Sales Only), PC A09/MF A01; OSTI; INIS.

During the period January 1987 - December 1988, the Spectroscopy Division has carried out research and development in many areas of analytical spectroscopy, atomic spectra and spectra of diatomic and polyatomic molecules. The Division has acquired an ICP spectrometer and an excimer laser pumped dye laser during this period and they have been used very fruitfully for research and development. Research in high resolution atomic spectroscopy has continued to flourish. Beam foil spectroscopy and spectroscopy of low energy plasma focus sources have been put on a firm foundation. Setting up of new experimental systems for solid state spectral studies at liquid helium temperatures have been started. A good amount of theoretical work in forbidden transitions, has been carried out. Diode laser spectroscopy has been used for high precision intensity and frequency measurements. Service facilities like quality control analysis of nuclear materials and supply of optical components and thin film devices have performed with maximum efficiency. The electronics and instrumentation group has developed several facilities for various experimental set ups. Brief description of all these and other activities of the Division are given in the present progress report. A list of publications and a divisional staff chart are also given. (author). figs., tabs.

41112 (BARC–1500 A9.1-A9.10) **Tritium analysis of samples obtained from various electrolysis experiments at BARC (Paper No. A9).** Murthy, T.S. (Bhabha Atomic Research Centre, Bombay (India). Isotope Group); Sen, B.K.; Joseph, T.B.; Iyengar, T.S. Bhabha Atomic Research Centre, Bombay (India). Dec 1989. In *BARC studies in cold fusion (April-September 1989)*. Order Number DE90632005. Available from NTIS (US Sales Only), PC A07/MF A01; OSTI; INIS.

Tritium in various samples obtained from a number of electrolysis experiments conducted in the Bhabha Atomic Research Centre, Bombay, to investigate the cold fusion phenomenon is determined. Samples were distilled and wherever possible were diluted with double distilled water to reduce the pH and to quench the impurities. Alternatively the sample was kept for chemiluminescence cooling. Commercially available scintillation cocktail INSTAGEL was used to prepare the sample for scintillation counting. Tritium content was determined in: (1) heavy water before electrolysis, (2) palladium cathodes, and (3) samples drawn at appropriate intervals to follow up the trend in tritium content values during electrolysis. Quench correction was carried out by one of the following methods: (1) standard addition technique, (2) sample channels ratio method or its variations. Data of tritium content collected during the various experiments are presented in tables. (M.G.B.). 5 tabs.

41113 (CONF-9009205–1) **PCB [polychlorinated biphenyl] analysis: Status and challenges.** Erickson, M.D. Argonne National Lab., IL (USA). May 1990. 9p. Sponsored by U.S. DOE Energy Research. DOE Contract W-31109-ENG-38. From International conference on organohalogen compounds (DIOXINE 90); Bayreuth (Germany, F.R.); 10-14 Sep 1990. Order Number DE90013666. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Present PCB analysis methods evolved from the old pesticide analysis methods using GC/ECD. These "classic" methods are still being improved upon and are heavily used. Newer methods using congener-specific high resolution GC/ECD and GC/MS have improved the specificity and information content of the analyses. Acceptable accuracy and precision with both classic and newer methods continue to be challenges to analysis. 19 refs., 1 fig.

41114 (IAEA-AL–028) **Preparation and provisional validation of a large size dried spike: Batch SAL-9931.** Jammet, G.; Zoigner, A.; Doubek, N.; Grabmueller, G.; Bagliano, G. International Atomic Energy Agency, Seibersdorf (Austria). Laboratories. May 1990. 38p. Order Number DE90632797. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

To determine uranium and plutonium concentration using isotope dilution mass spectrometry, weighed aliquands of a synthetic mixture containing about 2 mg of Pu (with a ^{239}Pu abundance of about 98%) and 40 mg of U (with a ^{235}U enrichment of about 19%) have been prepared and verified by SAL to be used to spike samples of concentrated spent fuel solutions with a high burn-up and a low ^{235}U enrichment. The advantages of such a Large Size Dried (LSD) Spike have been pointed out elsewhere and proof of the usefulness in the field reported. Certified Reference Materials Pu-NBL-126, natural U-NBS-960 and 93% enriched U-NBL-116 were used to prepare a stock solution containing 1.8 mg/ml of Pu and 37.3 mg/ml of 19.4% enriched U. Before shipment to the Reprocessing Plant, aliquands of the stock solution are dried to give Large Size Dried Spikes which resist shocks encountered during

transportation, so that they can readily be recovered quantitatively at the plant. This paper describes the preparation and the validation of a Large Size Dried Spike which is intended to be used as a common spike by the plant operator, the national and the IAEA inspectorates. 6 refs, 7 tabs.

41115 (IAEA-AL–029) **Preparation and provisional validation of a large size dried spike: Batch SAL-9934.** Jammet, G.; Zoigner, A.; Doubek, N.; Aigner, H.; Deron, S.; Bagliano, G. International Atomic Energy Agency, Seibersdorf (Austria). Laboratories. May 1990. 26p. Order Number DE90632798. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

To determine uranium and plutonium concentration using isotope dilution mass spectrometry, weighed aliquands of a synthetic mixture containing about 2 mg of Pu (with a ^{239}Pu abundance of about 98%) and 40 mg of U (with a ^{235}U enrichment of about 19%) have been prepared and verified by SAL to be used to spike samples of concentrated spent fuel solutions with a high burn-up and a low ^{235}U enrichment. Certified Reference Materials Pu-NBL-126, natural U-NBS-960 and 93% enriched U-NBL-116 were used to prepare a stock solution containing 3.2 mg/ml of Pu and 64.3 mg/ml of 18.8% enriched U. Before shipment to the Reprocessing Plant, aliquands of the stock solution are dried to give Large Size Dried (LSD) Spikes which resist shocks encountered during transportation, so that they can readily be recovered quantitatively at the plant. This paper describes the preparation and the validation of a third batch of LSD-Spike which is intended to be used as a common spike by the plant operator, the national and the IAEA inspectorates. 6 refs, 6 tabs.

41116 (IAEA-R–5545-F) **Zinc absorption study using an enriched stable isotope (^{70}Zn): Final report for the period 15 April 1989 - 15 April 1990.** Li Gongpan. Academia Sinica, Beijing, BJ (China). Inst. of Atomic Energy; International Atomic Energy Agency, Vienna (Austria). Apr 1990. 5p. Order Number DE90632799. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

A weaning food from fermented soybean was prepared for increasing the bioavailability of zinc. The zinc absorption was compared with that of a weaning food from non-fermented soybean and normal staple food. A stable isotope tracer technique (^{70}Zn) and neutron activation were used for determining the absorption of zinc. Nine children aged 7 to 18 months were tested. Zinc bioavailability of weaning food from fermented soybean is higher than that of normal weaning food. The weight increment and zinc nutrition of children having weaning food from fermented soybean are improved by this diet. 5 tabs.

41117 (IS-T–1466) **New chelating reagents for the separation of metal complexes by high performance liquid chromatography.** Main, M.V. Ames Lab., IA (USA). Jul 1990. 129p. Sponsored by U.S. DOE Energy Research. DOE Contract W-7405-ENG-82. Order Number DE90014427. Available from NTIS, PC A07/MF A01 - OSTI; GPO Dep.

New chelating reagents for the complexation of metal ions in aqueous samples have been developed. The reagents synthesized and tested were 2,6-diacetylpyridine bis(N-methylenepyridiniohydrazone) dichloride (abbreviated H_2dapmp), 2,6-diacetylpyridine bis(N-methylene-N,N,N-trimethylammonio-hydrazone) dichloride (abbreviated H_2dapmta), and 2-acetylpyridine-4-ethyl-3-thiosemicarbazone (abbreviated Hapet). All three chelating reagents proved to be useful for the separation and determination of metal ions by reverse-phase high performance liquid chromatography. Both H_2dapmp and H_2dapmta formed kinetically stable metal complexes that did not dissociate on the chromatographic column.

41118 (IS-T–1467) **Peak analysis in gas chromatography and the development of new stationary phases for anion chromatography.** Strasburg, R.F. Ames Lab., IA (USA). Jul 1990. 143p. Sponsored by U.S. DOE Energy Research. DOE Contract W-7405-ENG-82. Order Number DE90014428. Available from NTIS, PC A07/MF A01 - OSTI; GPO Dep.

Causes of band broadening in capillary, gas chromatography are investigated. Using the Golay equation, it is shown that the presence of a diluent significantly increases the extra-column variance, in early eluting peaks, when a liquid injection is used. The cause of this phenomenon is also discussed. A mathematical method based on an iterative method is developed to obtain the correct hold-up time of a capillary column using a flame ionization detector. This method takes advantage of the programmable ability of a common, hand-held calculator. Also is discussed is the application of this method for calculating Kovats indices and the calculation of capacity factors. The injection peak in single-column, anion exchange chromatography is used to quantitatively determine simple mixtures of cations in solution. A new, low capacity, anion-exchange resin is developed which possesses a unique selectivity for sulfate and oxalate over bromide and nitrate.

41119 (KFKI–1989-59/J) **Particle induced x-ray emission (PIXE) measurement of the Cd content in animal tissues.** Le Huong Quynh; Demeter, I.; Hollos-Nagy, K.; Szoekefalvi-Nagy, Z. Hungarian Academy of Sciences, Budapest (Hungary). Central Research Inst. for Physics. Dec 1989. 17p. Order Number DE90632801. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Particle induced x-ray emission (PIXE) measurements were performed on thin samples prepared from different rabbit tissues, using 3 MeV proton beam for inducing x-rays from the animal tissues. This method is very sensitive and very small amounts of trace elements can be detected. Cadmium, one of the most toxic elements which can be concentrated in animal and human tissues due to environmental pollution, was detected with a limit of 0.7 ppm. The trace element concentrations obtained by PIXE were compared to those measured by atomic absorption spectrometry. PIXE method is proposed for routine analysis at the Veterinary and Food Investigating Service, Budapest, Hungary. (D.Gy.) 6 refs.; 3 figs.

41120 (LA-UR–90-2000) **Intrinsic densitometry techniques for high-burnup plutonium solutions.** Hsue, S.-T. (Los Alamos National Lab., NM (USA)); Cromboom, O. Los Alamos National Lab., NM (USA). [1990]. 6p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-36. (CONF-9007106–7: Institute of nuclear materials management conference, Los Angeles, CA (USA), 15-18 Jul 1990). Order Number DE90013174. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Two intrinsic densitometry techniques for determining plutonium concentrations (and isotopic distributions) that require no external radioactive sources or x-ray generators and rely only on the natural radiation from the plutonium have been tested with high-burnup solutions. We found that these techniques can determine the plutonium concentration of high-burnup solutions to between 2.4% and 3.5% in a 1-h assay. 3 refs., 5 figs., 4 tabs.

41121 (MLM–3643(OP)) **Plutonium isotopic analysis of materials for NDA standards.** Tackett, J.R.; Ellefson, R.E. EG and G Mound Applied Technologies, Miamisburg, OH (USA). [1990]. 3p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-88DP43495. (CONF-9006241–2: 38. ASMS conference on mass spectrometry and allied topics, Tucson, AZ (USA), 4-8 Jun 1990). Order Number DE90014119. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

This paper describes tests performed on isotopically blended plutonium materials which are used to calibrate calorimeters and gamma spectrometers at the Savannah River Plant. 6 figs. (FSD)

41122 (ORNL/FTR–2549) **[Discussions in biotechnology and separations science]: Foreign trip report, April 17, 1987–May 2, 1987.** Scott, T.C. Oak Ridge National Lab., TN (USA). 14 May 1987. 7p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE90013143. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The traveler visited two research installations in West Germany to discuss biotechnology and separations science research and to attend and present an invited paper at the Second International Conference on Separations Technology at Schloss Elmau. The visit to the Juelich Nuclear Research center centered around discussions of biotechnology research with Professor M. Kula. The most interesting of these focused on contributions which could be carried out at ORNL and would involve interfacial transport phenomena in two-phase-polymer/aqueous extraction systems. Discussions at the

Institute fur Heisse Chemie (Karlsruhe) centered around separations science applications of high-intensity electric fields. The most important topic was definition of operating parameters useful for evaluation of the emulsion-phase-contactor concept developed at ORNL. The Second International Conference on Separations Technology provided a forum for exchanging ideas in the general area of separations science with internationally prominent scientists and engineers.

41123 (PB–90-207663/XAB) **XRF-spectral studies of solutions and matrix effects on analyte-line. Master's thesis.** Qadeer, R. Quaid-i-Azam Univ., Islamabad (Pakistan). Dept. of Chemistry. 1988. 161p. Available from NTIS, PC A08/MF A01.

The thesis discusses x-ray fluorescence spectral studies at trace level mixture solutions of uranium with typical fission products Sr, Zr, Ru, Cs, Ce and with lanthanides Sm, Eu, Gd, Dy and Hr. The fluorescence spectra of such complex matrices have been analyzed. Interferences of the matrix lines on the analyte line and their remedies have been described. Optimum experimental as well as spectral conditions for determination of: uranium in organic phase, uranium in aqueous phase of 3M HNO3, uranium in fission product in 3M HNO3, uranium in lanthanides in 3M HNO3, fission products elements in uranium fission product matrix in 3M HNO3, and lanthanides in lanthanides - uranium matrix in 3M HNO3 have been established using simulates. Spectral interferences and matrix effect like absorption enhancement have been rectified using calibration standards of similar composition with or without internal standard. Analytical application has been established on the basis of statistical evaluation.

41124 (UCRL-LR–103220-Vol.1) **MGA [Multi-Group Analysis]: A gamma-ray spectrum analysis code for determining plutonium isotopic abundances: Volume 1, Methods and algorithms.** Gunnink, R. Lawrence Livermore National Lab., CA (USA). 3 Apr 1990. 41p. Sponsored by U.S. DOE Defense Programs; Nuclear Regulatory Commission. DOE Contract W-7405-ENG-48. (ISPO–317). Order Number DE90013529. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Nondestructive measurements of x-ray and gamma-ray emissions can be used to analyze a sample for plutonium. This report describes the methods and algorithms we have developed for analyzing gamma-ray spectra obtained by using a germanium detector system to accurately determine the relative abundances of various actinide isotopes in a sample. Our methodology requires no calibrations and can be used to measure virtually any size and type of plutonium sample. Measurement times can be as short as a few minutes; measurements are frequently accurate to within 1%. Our methods have been programmed into a computerized analysis code called MGA (Multi-Group Analysis). Our current versions can be run on personal computers (IBM type) and on the DEC VAX microcomputer. Spectral analysis times are usually far less than a minute. 28 refs., 26 figs., 1 tab.

41125 Ionization of acetic acid in NaCl(aq) media: A potentiometric study to 573 K and 130 bar. Mesmer, R.E. (Oak Ridge National Lab., TN (USA)); Patterson, C.S.; Busey, R.H.; Holmes, H.F. *Journal of Physical Chemistry (USA),* 93(21): 7483-7490 (19 Oct 1989). DOE Contract AC05-84OR21400.

The ionization quotients of aqueous acetic acid have been determined precisely in NaCl(aq) media to 5 mol/kg from 50 to 300°C with a potentiometric cell previously developed at Oak Ridge National Laboratory. Pressure coefficients were also determined to 250°C. The cell contains hydrogen electrodes in a concentration cell configuration and is operated in a flow mode. Results have been combined with selected information in the literature and modeled by both the Pitzer ion-interaction treatment and a conventional ionic strength approach. Thermodynamic quantities for the ionization reaction have been derived including the equilibrium constant, activity coefficient quotients, and pressure coefficients, along with the changes in enthalpy, entropy, heat capacity, and volume for the reaction. Dramatic increases in negative values for $\Delta H°$, $\Delta S°$, $\Delta C_p°$, and $\Delta V°$ are seen that appear to extrapolate to negative infinity at the critical temperature along the saturation vapor pressure curve. However, increases in pressure and salinity diminish this trend until, for example, at a density of 1 g/cm^3 the quantities remain relatively constant as has been shown for other such processes involving ions. These results provide the first measurements of the activity coefficient ratio for the ionization of an organic acid at high temperatures. The results provide a basis for use of acetic acid-acetate as a relatively stable buffer for physical chemical studies and as a protonated ligand for metal complexation measurements of the kind reported recently from this laboratory. A comparison of the ionization constants and enthalpies for ionization of several organic acids shows modest trends with the electron-releasing character of the carboxylate.

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Refer also to citation(s) 40408, 40448, 40484, 41008, 41009, 41010, 41011, 41012, 41013, 41014, 41015, 41016, 41017, 41018, 41020, 41021, 41022, 41023, 41027, 41036, 41040, 41050, 41090, 41125, 41233, 41237, 41498, 41814, 42237

41126 (DOE/ER/13832–12) **Metal ion complexation by ionizable crown ethers: Progress report, January 1, 1988–December 31, 1990.** Bartsch, R.A. Texas Tech Univ., Lubbock, TX (USA). Jun 1990. 46p. Sponsored by U.S. DOE Energy Research. DOE Contract FG05-88ER13832. Order Number DE90013956. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

During the report period a variety of new lipophilic ionizable crown ethers with pendent proton-ionizable groups has been synthesized. In addition a series of proton-ionizable crown ethers without lipophilic groups was prepared to study how structural variations within the ligand influence metal ion complexation in homogeneous media as assessed by NMR spectroscopy or titration calorimetry. A third class of new metal ion-complexing agents is a series of lipophilic acyclic polyether dicarboxylic acids. Competitive solvent extractions of alkali metal and alkaline earth cations and of the mixed species have been conducted to reveal the influence of ring size, nature and attachment site of the lipophilic group, sidearm length, and proton-ionizable group identity and location upon the selectivity and efficiency of metal ion complexation. In addition to such studies of structural variation within the lipophilic proton-ionizable crown ether, the effect of changing the organic solvent and variation of the stripping conditions have been assessed. The ability of proton- ionizable crown ethers to function as selective metal ion carriers in liquid membrane transport processes has been examined in both bulk liquid membrane and polymer-supported liquid membrane transport systems. New acyclic and cyclic polyether carboxylic acid resins have been prepared by condensation polymerization and characterized.

41127 (LA-UR–90-1762) **Hydrogen isotopic exchange over palladium metal.** Carstens, D.H.W.; Encinias, P.D. Los Alamos National Lab., NM (USA). [1990]. 12p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-36. (CONF-9009141–1: International symposium on metal-hydrogen systems, Banff (Canada), 2-7 Sep 1990). Order Number DE90012063. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

We have recently developed the laser-Raman technique as a means of unambiguously measuring the partial pressures of all possible hydrogen isotopes in the gas phase. Using this technique we have investigated the hydrogen-deuterium exchange in a number of metals. This report presents detailed data for isotopic exchange in the palladium hydride system over the temperature range 26°C to -100°C at a pressure of 7 atm. First order kinetic rate constants and activation energies are summarized for the forward (hydride to deuteride) and reverse (deuteride to hydride) exchange processes. In addition, we have found that small amounts (100 ppm) of impurities in the exchange gases considerably slow the exchange kinetics with the effect increasing down the series CH_4, CO_2, H_2O, and CO. 9 refs., 4 figs., 1 tab.

41128 (LA-UR–90-1959) **Algorithmic chemistry: A model for functional self-organization.** Fontana, W. Los Alamos National Lab., NM (USA). [1990]. 48p. Sponsored by U.S. DOE Management & Administration. DOE Contract W-7405-ENG-36. (CONF-9009191–1: Animals to animates conference, Paris (France), Sep 1990). Order Number DE90013183. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

We conjecture that adaptive systems are characterized by a self-referential loop in which combinatorial objects encode functions that act back on these objects. A model for this loop is presented. It uses a simple and powerful recursive language to map character strings into algorithms that symbolically manipulate strings. The interaction between algorithms, i.e. functions, can be defined in a natural way within the language. The behavior of a fixed size ensemble of functions acting on each other is studied under various conditions. The "function gas," or "Turing gas," evolves cooperative interaction patterns of considerable intricacy. Such patterns are observed to adapt under the influence of perturbations consisting in the addition of new random functions to the system. Completely different organizational architectures emerge depending on the availability of self-replicators.

41129 (LBL–28970) **Density effects on the molecular dynamics of the I_2 geminate recombination reaction in liquid Xe.** Paige, M.E. Lawrence Berkeley Lab., CA (USA). May 1990. 149p. Sponsored by U.S. Department of Defense; National Science Foundation. DOE Contract AC03-76SF00098. Order Number DE90013353. Available from NTIS, PC A08/MF A01 - OSTI; GPO Dep.

The dynamics of the I_2 geminate (original partner) recombination reaction in liquid Xe are examined as a function of solvent density and temperature through picosecond transient absorption spectroscopy. Specifically, the vibrational relaxation of I_2 on its ground state potential surface and the nonradiative curve crossing of molecules originally recombining on the A′ state to the ground state are studied. The experiments are performed at 280 K over a range of Xe densities which span the entire liquid phase portion of the Xe phase diagram. The temperature dependence of the dynamics is determined between 253 and 323 K at constant Xe density. Solvent density effects on the ground state absorption coefficients are calculated. 80 refs., 27 figs., 9 tabs.

41130 (UCID–20824-Add.1) **Chemical TOPAZ: Modifications to the heat transfer code TOPAZ: The addition of chemical reaction kinetics and chemical mixtures: Addenda 1.** Nichols, A.L. III. Lawrence Livermore National Lab., CA (USA). 7 Jun 1990. 24p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. Order Number DE90014725. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This is a report describing the modifications which have been made to the heat flow code TOPAZ to allow the inclusion of thermally controlled chemical kinetics. This report is broken into parts. The first part is an introduction to the general assumptions and theoretical underpinning that were used to develop the model. The second section describes the changes that have been implemented into the code. The third section is the users manual for the input for the code. The fourth section is a compilation of hints, common errors, and things to be aware of while you are getting started. The fifth section gives a sample problem using the new code. This manual addenda is written with the presumption that most readers are not fluent with chemical concepts. Therefore, we shall in this section endeavor to describe the requirements that must be met before chemistry can occur and how we have modeled the chemistry in the code.

41131 American Chemical Society, Division of Colloid and Surface Chemistry. 153p. American Chemical Society, Washington, DC (US) (1990). (CONF-900402–: 199. national meeting of the American Chemical Society, Boston, MA (USA), 22-27 Apr 1990).

Separate abstracts were prepared for 79 papers of this conference.

41132 Electric field effects on adsorbate hybridization. Yates, J.T. Jr. (Univ. of Pittsburgh, PA (USA)); Zhi Xu; Hanley, L. pp. 68 of American Chemical Society, Division of Colloid and Surface Chemistry. American Chemical Society, Washington, DC (US) (1990). (CONF-900402–: 199. national meeting of the American Chemical Society, Boston, MA (USA), 22-27 Apr 1990).

The CO adlayer on Ni(111) consists of a mixture of terminal-CO and bridged-CO species with different dipole moments and with an adsorption energy difference of ~0.2 kcal $mole^{-1}$. Adsorption of a second layer of a number of non-reacting molecules at 100 K is observed to always lower the work function of the surface due to polarization of this outer layer. Using infrared reflection-absorption spectroscopy (IRAS) they have observed that the polarized outer layer causes conversion from terminal-CO to bridged-CO hybridized states.

41133 The Cu/W(110) bimetallic system: The role of interface states in the dissociative chemisorption of O_2. Houston, J.E. (Sandia National Labs., Albuquerque, NM (USA)). pp. 69 of American Chemical Society, Division of Colloid and Surface Chemistry. American Chemical Society, Washington, DC (US) (1990). (CONF-900402–: 199. national meeting of the American Chemical Society, Boston, MA (USA), 22-27 Apr 1990).

Recent studies by Gomer and coworkers have shown that the O_2 dissociative sticking coefficient is unique for 1ML Cu/W(110). At the 1ML level, Cu grows pseudomorphic to the W(110) surface and is under a uniaxial strain of almost 25%, with respect to bulk Cu, indicating a strong Cu/W interfacial interaction. The authors have used angle-resolved photoemission to probe the properties of the Cu/W interface states. In the present paper, they outline the results of these studies, compare them to data obtained from other bimetallic systems; and along with results from LEED, EELS, and TPD, discuss their implications with respect to O_2 dissociative adsorption.

41134 The application of new techniques to study surface structure on the atomic scale. LEED, STM, AFM and SIMS. Somorjai, G.A. (Lawrence Berkeley Lab., CA (USA)). pp. 76 of American Chemical Society, Division of Colloid and Surface Chemistry. American Chemical Society, Washington, DC (US) (1990). (CONF-900402–: 199. national meeting of the American Chemical Society, Boston, MA (USA), 22-27 Apr 1990).

Using channel plates and superior computer control detection techniques, low energy electron diffraction can now be used to study the structure of disordered monolayers of atoms and molecules. Studies of the surface structure of more complex adsorbed layers is facilitated by tensor LEED a new computational technique. The scanning tunneling microscope and the atomic force microscope provide atomic spatial resolution to study the solid-vacuum, solid-gas and solid-liquid interfaces. New accomplishments of research using these techniques will be demonstrated. The secondary ion mass spectroscopy technique shows surprising sensitivity to surface structure and bonding and promise to be an importance tool in surface structural studies.

41135 Chemical reactions during the thermal processing of borazene polymers. Rye, R.R. (Sandia National Labs., Albuquerque, NM (USA)); Paine, R.T. pp. 76-77 of American Chemical Society, Division of Colloid and Surface Chemistry. American Chemical Society, Washington, DC (US) (1990). (CONF-900402–: 199. national meeting of the American Chemical Society, Boston, MA (USA), 22-27 Apr 1990).

A class of borazene polymers has been developed which consist of a two-dimensional array of six-membered borazene rings with the borons of adjacent borazene rings separated by -NH- groups. The thermal chemistry of thin films of one polymer deposited on KOH etched Al has been examined by thermal decomposition mass spectroscopy (TDMS) and thermal gravimetric analysis (TGA), and the gas evolution chemistry is found to be essentially complete by temperatures of less than 400 C. Since the formation of ordered crystalline h-BN films requires heating to temperatures of the order of 1,000 C while the gas evolution chemistry is complete by roughly 400 C, it is concluded that gas evolution chemical processes are not rate limiting in BN ceramic production. The character of the chemical species produced by 400 C and the thermal limiting steps will be discussed.

41136 Surface chemistry of trimethylgallium on gallium arsenide. Creighton, J.R. (Sandia National Labs., Albuquerque, NM (USA)). pp. 77 of American Chemical Society, Division of Colloid and Surface Chemistry. American Chemical Society, Washington, DC (US) (1990). (CONF-900402–: 199. national meeting of the American Chemical Society, Boston, MA (USA), 22-27 Apr 1990).

The adsorption properties of trimethylgallium on the gallium-rich (4 x 6) and (1 x 6) GaAs (100) surfaces have been studied by temperature programmed desorption, LEED, and Auger electron spectroscopy. The authors present structural models for the

gallium-rich GaAs(100) surfaces before and after TMGa chemisorption which are consistent with all of their observations.

41137 Nucleation and growth of AlN on silica and Si(100). Rogers, J.W. Jr. (Sandia National Labs., Albuquerque, NM (USA)); Bartram, M.E.; Michalske, T.A.; Mayer, T.M. pp. 82 of American Chemical Society, Division of Colloid and Surface Chemistry. American Chemical Society, Washington, DC (US) (1990). DOE Contract AC04-76DP00789. (CONF-900402--: 199. national meeting of the American Chemical Society, Boston, MA (USA), 22-27 Apr 1990).

FTIR, TPD, and XPS have been used to study the nucleation and decomposition of AlN precursors on the surface of silica and Si(100). NH_3 reacts selectively with the aluminum alkyl surface complex produced by trimethylaluminum (TMA) chemisorption to form a new product on the surface that is stable in high vacuum at 300K. Formation of this surface adduct alters the chemistry of the O-Si linkage. Formation of this surface adduct alters the chemistry of the aluminum alkyl component and leads to -NH_2-cross-linking between the aluminum alkyl centers by 550 K. This surface chemistry will be compared to that of the analogous systems, NH_3 + tricthylaluminum and triisobutylaluminum on silica.

41138 Synthetic zeolites. Kerr, G.T. *Scientific American (USA)*, 261(1): 100-105 (Jul 1989).

Analyses of chemistry and structure have shown that zeolites are highly porous crystals, veined with submicroscopic channels. Synthetic forms of zeolite catalysts yield from 10 to 20 percent more gasoline in the catalytic cracking of petroleum than did earlier catalysts, and they do so cleanly and at lower, energy-saving temperatures. Investigators continue to seek new forms of synthetic zeolites. The paper reviews the properties and the development of synthetic zeolites. Some of the most interesting zeolites developed are not zeolites in the strict sense of the term; they are based on a phosphorus rather than a silicon structure.

41139 Role of nuclear tunneling in aqueous ferrous–ferric electron transfer. Bader, J.S. (Department of Chemistry, University of California, Berkeley, Berkeley, California 94720 (USA)); Kuharski, R.A.; Chandler, D. *Journal of Chemical Physics (USA)*, 93(1): 230-236 (1 Jul 1990).

By computer simulation and also by analytical methods we have computed the nuclear tunneling enhancement of the rate for ferrous–ferric exchange in water. The model we have examined is the one studied earlier where we treated water as a classical liquid [R. A. Kuharski, J. S. Bader, D. Chandler, M. Sprik, M. L. Klein, and R. W. Impey, J. Chem. Phys. **89**, 3248 (1988)]. But now we treat water quantum mechanically and find that the tunneling enhancement is a factor of 60 in the rate constant. Further, as observed experimentally, we find that the isotope shift on the rate when changing from D_2O to H_2O is approximately a factor of 2. The computer simulation aspects of these calculations employ path integral methods and a novel partitioning of the free energy associated with electron transfer. Our results show that it is insufficient to quantize only the atoms composing the ligands. The quantum dynamics of water molecules beyond the first solvation shell prove quite significant.

41140 Potential energy surfaces of eight low-lying electronic states of Rh_3. Das, K.K. (Department of Chemistry, Arizona State University, Tempe, Arizona 85287-1604 (USA)); Balasubramanian, K. *Journal of Chemical Physics (USA)*, 93(1): 625-632 (1 Jul 1990). DOE Contract FG02-86ER13558.

Complete active space multiconfiguration self-consistent-field (CASSCF) followed by multireference singles plus doubles configuration-interaction (MRSDCI) calculations which include 27 active electrons are carried out on eight low-lying electronic states of Rh_3. The MRSDCI calculations included up to 2.3 million configurations. The spin-orbit effects are included by using the relativistic configuration-interaction (RCI) method. All the low-lying states considered here lie within 0.20 eV. All the doublet states are Jahn–Teller components of the doubly degenerate $^2E'$ and $^2E''$ states in equilateral triangular geometry (D_{3h}), while the quartet states arise from the Jahn–Teller components of $^4E'$ and $^4E''$ states. The splittings between the two Jahn–Teller components of both the $^2E'$ and $^2E''$ states, which yield barriers to pseudorotation, are 3.9 kcal/mol. The lowest-lying $^2A_2$ and $^2A_1$ states are separated only by 0.03 eV. Thus, low-lying electronic states of Rh_3 are best described using a dynamic Jahn–Teller model. The Mulliken population analyses of the MRSDCI natural orbitals reveal the larger *s* population of the apex atom of the isosceles triangle in comparison to the base atoms. The base atoms have larger *d* populations for all electronic states. The present calculations also reveal a considerable mixing among the $4d^85s^1$, $4d^9$, and $4d^85p^1$ configurations of the rhodium atom. The atomization energy of Rh_3 is calculated as 188 kcal/mol. The trimer (Rh_3) is predicted to be considerably more stable than the dimer (Rh_2).

41141 The transition temperatures and dynamics for the argon–xenon N=7 mixed cluster series. Robertson, D.H. (Department of Chemistry, Florida State University, Tallahassee, FL (USA)); Brown, F.B. *Journal of Chemical Physics (USA)*, 93(1): 702-710 (1 Jul 1990). DOE Contract FC05-85ER25000.

Results of molecular-dynamics calculations with quenching for the N=7 Ar–Xe mixed cluster series are reported. The phase-transition temperatures have been determined and are discussed. The microscopic transitions between catchment regions on the potential-energy surface are examined as well as the total amount of time spent in each of these catchment regions. The mixed cluster results are compared to the homogeneous results. The heterogeneous dynamics are found to more closely reproduce the homogeneous results if the heterogeneous catchment regions are classified according to their associated homogeneous parent minimum.

41142 The kinetics of CO desorption from Ni(110). Feigerle, C.S. (Department of Chemistry, University of Tennessee, Knoxville, Tennessee 37996-1600 (USA)); Desai, S.R.; Overbury, S.H. *Journal of Chemical Physics (USA)*, 93(1): 787-794 (1 Jul 1990). DOE Contract AC05-84OR21400.

The kinetics of CO desorption from clean Ni(110) have been measured by thermal desorption mass spectrometry (TDMS) using the method of variation of heating rates. Analysis of the desorption spectra gives the coverage dependence of the preexponential factor ν_d, and the activation energy E_d, of the desorption rate constant. For $0<\theta<0.5$, E_d is constant at 30.6 kcal/mol, allowing analysis of the coverage dependence of the preexponential factor under conditions where the compensation effect is absent. We observe only small changes in the preexponential factor under these conditions, where $\log[\nu_d(s^{-1})]$ rises slowly from 14.6 to 15.3 from $0<\theta<0.65$. Near θ=0.8, a synchronous drop in ν_d by 0.6 orders of magnitude and in E_d by 5 kcal/mol is observed at the onset of formation of the $(2\times1)p2mg$ structure. These results are discussed in light of the structures of CO in Ni(110) and the effects of ordering transitions on the desorption kinetics. The experimental results for $\nu_d(\theta)$ are compared with those predicted for desorption by three precursor mechanisms and for desorption of a lattice gas with lateral interactions.

41143 The infrared spectrum of difluorovinylidene, $F_2C{=}C$. Gallo, M.M. (Center for Computational Quantum Chemistry, University of Georgia, Athens, Georgia 30602 (USA)); Schaefer, H.F. III. *Journal of Chemical Physics (USA)*, 93(1): 865-866 (1 Jul 1990). DOE Contract FG09-87ER13811.

Single and double excitation coupled cluster theory was applied in conjunction with a double zeta plus polarization basis set to the prediction of the infrared spectrum of difluorovinylidene, a target molecule of considerable current experimental interest. The C–F asymmetric stretch estimated at 1260 cm^{-1} has a very strong IR intensity, about 300 km/mole. Parallel studies of difluoroacetylene are reported.

41144 Vibrational study of CO_2^- on k-promoted Pt(111). Liu, Z.M. (Univ. of Texas, Austin (USA)); Zhou, Y.; Solymosi, F.; White, J.M. *Journal of Physical Chemistry (USA)*, 93(11): 4383-4385 (1 Jun 1989).

The adsorption of CO_2 on K-dosed Pt(111) was studied by high-resolution electron energy loss and thermal desorption spectroscopy. Adsorption of CO_2 produced measurable vibrational spectra at low K coverage (θ_K = 0.05) as well as for a multilayer of K (θ_K = 1.27). At a K coverage of $\theta_K \approx 0.49$, intense losses were observed at 1600 ± 20, 1340 ± 20, and 820 ± 20 cm^{-1} tentatively attributed to the asymmetric stretching, symmetric stretching,

and the bending modes of a bent CO_2^- species formed by the direct interaction of metallic potassium and CO_2. CO_2^- may be stabilized in the form of a dimer or oxalate. Above 200 K, this surface species is transformed into carbonate and CO, which are characterized by loss features at 1440 ± 20 and 1600 ± 20 cm^{-1}, respectively. CO desorbs above 600 K (T_p = 640 K), while carbonate decomposes above 650 K (T_p = 674 and 790 K).

41145 Radical ion recombination in photoionization: Observations by fluorescence detected magnetic resonance. Percy, L.T. (Argonne National Lab., IL (USA)); Bakker, M.G.; Trifunac, A.D. *Journal of Physical Chemistry (USA),* 93(11): 4393-4396 (1 Jun 1989). DOE Contract W-31-109-ENG-38.

Observations of time-resolved fluorescence detected magnetic resonance (FDMR) from the fluorescent recombination of geminate radical ion pairs produced by laser photoionization of scintillators in alcohols and ethers are described. The FDMR spectrum of the geminate radical ion pair produced from N,N,N′,N′-tetramethyl-p-phenylenediamine (TMPD) in 2-propanol was resolved and assigned to the TMPD radical cation and the solvated electron. An FDMR signal was observed in hydrocarbons with small amounts of added alcohol, but not in neat hydrocarbons. In all cases, the FDMR signal observed was a resonant decrease in fluorescence intensity, indicating that photoionization occurs predominantly from singlet excited states. It is concluded that stabilization of he geminate ion pair by electron solvation is a key requirement for the observation of FDMR from the recombination of geminate ion pairs produced by photoionization.

41146 Synthesis and identification by infrared spectroscopy of gaseous nitryl bromide, $BrNO_2$. Finlayson-Pitts, B.J. (California State-Univ., Fullerton (USA)); Livingston, F.E.; Berko, H.N. *Journal of Physical Chemistry (USA),* 93(11): 4397-4400 (1 Jun 1989).

The reactions at 298 K of gaseous N_2O_5 with NaBr(s) or with BrNO(g) in 1 atm of helium were followed by using Fourier transform infrared spectroscopy. In both cases, the formation of infrared absorption bands at 787, 1292, and approximately 1660 cm^{-1}, which could not be assigned to known reactant or product species, was observed. Based in part on published low-temperature matrix spectra, we assign these bands to gaseous nitryl bromide ($BrNO_2$). This appears to be the first gas-phase infrared spectroscopic observation of this nitryl halide.

41147 Kinetics of the methoxy radical decomposition reaction: Theory and experiment. Page, M. (Naval Research Lab., Washington, DC (USA)); Lin, M.C.; He, Yisheng; Choudhury, T.K. *Journal of Physical Chemistry (USA),* 93(11): 4404-4408 (1 Jun 1989).

The rate constant for the unimolecular decomposition of the methoxy radical, $CH_3O + M \rightarrow CH_2O + H + M$, is determined both theoretically and experimentally. In the theoretical calculations, potential energy surface information is obtained from ab initio multiconfiguration SCF and multireference configuration interaction calculations using basis sets of up to triple-plus polarization quality. The zero point corrected forward and reverse barriers are calculated to be 25.6 and 8.0 kcal/mol, respectively. RRKM rate calculations are performed incorporating a quantum correction due to tunneling through an Eckart barrier fit to represent the MRCI/TZP energetics and the shape of the MC-SCF/DZP vibrationally adiabatic potential energy curve in the saddle point region. The calculated values compare closely with experimental data derived from kinetic modeling of CO formation rates measured in the thermal decomposition of methyl nitrite at 550-700 K in a static cell and at 1060-1620 K in shock waves.

41148 Picosecond transient absorption spectroscopy of polysilanes. Ohsako, Y. (Univ. of Pennsylvania, Philadelphia (USA)); Thorne, J.R.G.; Phillips, C.M.; Zeigler, J.M.; Hochstrasser, R.M. *Journal of Physical Chemistry (USA),* 93(11): 4408-4411 (1 Jun 1989).

Transient absorption spectra have been recorded in the range 350-750 nm in solution at room temperature for poly(phenylmethylsilane). A transient absorption band at 450 nm resembles that of pHMeSi, and a band at 370 nm is another product. Both rise time and decay times of the transients were determined. Room temperature hole burning of the absorption spectrum is reported.

41149 Physical chemistry of high-temperature oxide superconductors. Ramakrishnan, T.V. (Indian Institute of Science, Bangalore (India)); Rao, C.N.R. *Journal of Physical Chemistry (USA),* 93(11): 4414-4422 (1 Jun 1989).

The discovery of high-temperature superconductivity in metal cuprates has ushered in a new era in the chemistry and physics of solids. At the same time, it has also highlighted our inadequate knowledge of the electronic structures of metal oxides. In this Feature Article, we briefly discuss the structure and properties of the different families of oxide superconductors discovered since 1986, paying specific attention to the states of copper and oxygen in the cuprates. We list those experimental observations related to the superconducting and normal states that have to be explained by theoretical models and present an overview of the current theoretical models. We conclude by indicating possible future directions.

41150 Bond orders from ab initio calculations and a test of the principle of bond order conservation. Lendvay, G. (Central Research Institute for Chemistry, Budapest (Hungary)). *Journal of Physical Chemistry (USA),* 93(11): 4422-4429 (1 Jun 1989).

Bond orders and valence indexes of atoms were calculated from ab initio wave functions using the definition suggested by Mayer. Changes of these quantities were investigated under conditions occurring in chemical reactions. Calculations were performed to reveal the dependence of bond orders on bond length. The results are compared with Pauling's bond order-bond length relation. Bond orders were also calculated in triatomic metathesis reactions. Bond orders are able to describe the similarity of the transition state of reactants or products. Along the minimum-energy path the principle of conservation of bond order is valid a good approximation. The obtained correlations are applied to a bond energy-bond order type model to estimate trends in reaction series.

41151 Electrostatic properties of L-alanine from x-ray diffraction at 23 K and ab initio calculations. Destro, R. (Universita di Milano (Italy)); Bianchi, R.; Morosi, G. *Journal of Physical Chemistry (USA),* 93(11): 4447-4457 (1 Jun 1989).

Maps of the electrostatic potential of L-alnine have been derived from single-crystal X-ray diffraction data collected at 23 (1) K and interpreted with a multipole (pseudoatoms) formalism. In the crystal, minimia in the potential of virtually identical magnitudes are observed near both oxygen atoms, in spite of their different environments. For an isolated, zwitterionic molecule constructed by assembling the pseudoatoms, a single minimum of -500 (42) kJ mol^{-1} | e |$^{-1}$ is obtained. Its position, which differs from those of the minima in the crystal, is at 1.15 Å from an oxygen atom-the one that forms two hydrogen bonds in the crystal structure- and along the line connecting, in the crystal, the oxygen and hydrogen atoms involved in the shortest hydrogen bond. Theoretical maps of the electrostatic potential, calculated by self-consistent field molecular orbital (SCF MO) ab initio methods with four different basis sets, have been compared with those derived from the experiment. In the region of the carboxylate group the best agreement is obtained with maps computed with the largest basis set here employed, of double-ζ plus polarization quality (6-31 G**). From various multipole models adopted to analyze the X-ray data, values of 12.7 (7)-13.1 (7) D are derived for | μ |, the magnitude of the molecular dipole moment of L-alanine in the solid state, to be compared with literature values, 12.3-17.0 D, of solution measurements. For an isolated molecule of the amino acid, the theoretical estimates of | μ | with our basis sets are in the range 12.0-12.9 D. Atomic electric field gradients (EFG) have also been derived from the results of the X-ray diffraction experiment, and the corresponding asymmetry parameters η and quadrupole coupling constants (QCC) e^2qQ/h evaluated.

41152 Potential energy surfaces for Nb + H_2 reaction. Balasubramanian, K. (Arizona State Univ., Tempe (USA)); Ravimohan, C. *Journal of Physical Chemistry (USA),* 93(11): 4490-4494 (1 Jun 1989).

Complete active space MCSCF (CASSCF) followed by multireference singles and doubles CI (MRSDCI) calculations are carried

out on 12 potential energy surfaces of Nb + H_2 arising from ^6D, ^4F, and ^2G states of the niobium atom. The geometries and energy separations of the bent minima and linear points in the potential energy surfaces of these electronic states of NbH_2 are calculated. The ground electronic state of NbH_2 was found to be of $^4B_1$ symmetry with a bent equilibrium geometry (r_e = 1.76 Å, θ_e = 127°). There are nine electronic states with bent minima, nine linear electronic states, and five saddle points among the calculated NbH_2 surfaces. It is found that the niobium atom in the ^6D ground state has to surmount a large barrier for the insertion into the H_2 bond while the low-lying excited ^4F and ^2G states of the niobium atom insert almost spontaneously into the H_2 bond.

41153 Influence of basis sets and electron correlation on theoretically predicted infrared intensities. Miller, M.D. (Almaden Research Center, San Jose, CA (USA)); Jensen, F.; Chapman, O.L.; Houk, K.N. *Journal of Physical Chemistry (USA),* 93(11): 4495-4502 (1 Jun 1989).

A systematic study of the effects of basis sets and electron correlation on calculated infrared intensities has been performed with ab initio molecular orbital calculations and Moeller-Plesset perturbation theory. Absolute IR intensities of hydrogen fluoride, hydroxy radical, carbon monoxide, hydrogen cyanide, and formaldehyde have been calculated with basis sets ranging from 3-21G to 6-311++G(2dd′,2pp′) and with electron correlation corrections up through MP4(SDTQ). A basis set with polarization and diffuse functions is necessary to obtain reasonably accurate intensities. Electron correlation significantly improves the agreement between experimental and calculated values. Except for carbon monoxide, the intensities calculated at the MP4 level compare favorably with experimental intensities, the errors being less than the measured difference between those obtained from inert-gas matrices at low temperature and those reported for the gas phase.

41154 UV excimer laser photoproducts from absorbing and transparent surfaces covered by aluminum alkyl adsorbates. Zhang, Y. (Max-Planck-Institut fuer Biophysikalische Chemie, Goettingen (Germany, F.R.)); Stuke, M. *Journal of Physical Chemistry (USA),* 93(11): 4503-4507 (1 Jun 1989).

Neutral atomic and molecular species, generated upon the interaction of UV excimer laser light with Al-alkyl/substrate interfaces, are detected by single-shot dye laser mass spectroscopy. The molecules studied at 308, 248, and 193 nm are trimethylaluminum (TMA), triethylaluminum (TEA), and triisobutylaluminum (TIBA). The substrate is either n-type Si(100) or SiO_2 (quartz). The major aluminum-containing species detected are Al atoms and AlH and $AlCH_3$ molecules. Their relative abundance is shown to depend on the absorbate molecule and the wavelength chosen. Marked differences are observed between the case of the Al-alkyls photolyzed under collision-free conditions in the gas phase and when these molecules are adsorbed to a substrate.

41155 Determination of the phosphorescence quantum yield of singlet molecular oxygen ($^1\Delta_g$) in five different solvents. Schmidt, R. (Universitaet Frankfurt (Germany, F.R.)); Seikel, K.; Brauer, H.D. *Journal of Physical Chemistry (USA),* 93(11): 4507-4511 (1 Jun 1989).

The quantum yield of singlet oxygen ($^1O_2$) $^1\Delta_g$ (v = 0) → $^1\Sigma_g^-$ (v = O) phosphorescence was determined in acetonitrile, chloroform, carbon disulfide, carbon tetrachloride, and Freon 113 relative to the respective emission in benzene, using the known $^1O_2$ phosphorescence quantum yield in benzene as standard. Quantum yields were not found to depend on sensitizer (dicyanoanthracene, rubicene, tetraphenylporphine) but to depend strongly on solvent. The $^1O_2$ phosphorescence quantum yields are surprisingly large. The maximum value measured is Qp (Freon 113) = 0.15. The emission quantum yields correlate linearly with $^1O_2$ lifetimes for all solvents, including benzene. Consequently the rate constant of $^1O_2$ phosphorescence is independent of solvent. It amounts to k_p = 1.3 s^{-1}. Thus the radiative rate constant is approximately 5000 times larger in liquid solution than for an isolated $^1O_2$ molecule.

41156 Ligand-ligand charge-transfer excited states of Os(II) complexes. Perkins, T.A. (Univ. of Florida, Gainesville (USA)); Schanze, K.S.; Pourreau, D.B.; Netzel, T.L. *Journal of Physical Chemistry (USA),* 93(11): 4511-4522 (1 Jun 1989).

This paper examines the photophysics of metal-to-ligand charge-transfer (MLCT) and ligand-to-ligand charge-transfer (LLCT) excited states in a series of $[(bpy)_2Os^{II}(CO)L]^{2+}$ (Os-L) complexes. For each of the complexes studied, the $d\pi(Os) \rightarrow \pi^*(bpy)$ absorption band is the lowest energy transition that is apparent. For L = pyridine and benzonitrile, only long-lived, highly luminescent MLCT states are observed. However, when L = an electron-donor aminobenzonitrile (ABN) species (DMABN, TMABN, or CMI; see text), MLCT emission is quenched and in < 30 ps LLCT excited states are formed, $^*[(bpy^{\bullet-})\text{-}(bpy)OS^{II}(CO)ABN^{\bullet+}]^{2+}$. The observed, weight-average radiationless decays of the LLCT excited states in acetonitrile and dichloromethane follow the squence Os-DMABN < Os-TMABN < Os-CMI in each solvent, and the calculated energies of the LLCT states for these complexes are in inverse order to the decay rates as expected if an energy gap law is followed. Finally, multiexponential relaxations of the LLCT states are pronounced in the nonpolar solvent dichloromethane. The dependence of these relaxations on the concentration of added electrolyte suggests that they may be due to ion-pair structure and dynamics.

41157 Dynamics of the Wolff rearrangement of six-membered ring o-diazo ketones by laser flash photolysis. Tanigaki, Ktasumi (Univ. of Notre Dame, IN (USA)); Ebbesen, T.W. *Journal of Physical Chemistry (USA),* 93(11): 4531-4536 (1 Jun 1989).

The Wolff rearrangement of six-membered ring o-diazo ketones, 1-oxo-2-diazo-1,2-dihydronaphthalene (DNQ) and its four 4- and 5-sulfonate analogues, 1-oxo-2-diazo-1,2-dihydrobenzene (DBQ), and diazoMeldrum (DM), are studied in solution at room temperature by laser flash photolysis. A precursor to a ketene is observed in most cases. It is assigned to be an oxirene on the basis of reactivity, kinetic results, and thermodynamic results. The Wolff rearrangement does not involve a concerted mechanism but a stepwise reaction for these types of diazo ketones. Thermodynamic analyses indicate that the activation barriers for the transformation of the oxirenes into ketenes are very low, typically 10-20 kJ/mol, in good agreement with theoretical predictions in the literature. The observation of oxirene in solution in nanosecond time scales, and longer, is attributed to the low preexponential factors due to the negative entropy of solvation. The important role of the solvent is further confirmed in the kinetic analysis of ketene formation in various water-methanol mixtures.

41158 Interfacial stoichiometry of a microemulsion system. Rosano, H.L. (City College of the City Univ. of New York, NY (USA)); Nixon, A.L.; Cavallo, J.L. *Journal of Physical Chemistry (USA),* 93(11): 4536-4539 (1 Jun 1989).

An o/w emulsion (4 g of sodium dodecyl sulfate (SDS); 4 mL of n-hexadecane (n-C_{16})/20 mL of H_2O) was titrated to clarity with 1-pentanol (n-C_5OH). When (1) n-C_5OH volume versus H_2O volume and (2) n-C_{16} volume versus n-C_5OH volume were plotted, two straight lines were obtained. The microdroplet is assumed to be an interfacial sheath with a n-C_{16} core and n-C_5OH distributed between three phases, oil, water, and the interface. The amount of n-C_5OH in the oil core and in the continuous phase was determined. The minimum volume of n-C_{16} required to form a microemulsion was also determined. From the experiments the calculated molar interfacial stoichiometry was found to be 2 n-C_5OH/3.5 SDS/1 n-C_{16}. To substantiate the proposed model, DSC curves of frozen microemulsion containing various volumes on n-C_5OH were investigated. Peak temperatures were found to be n-C_{16} (18.33°C), H_2O (−2.04°C), and the interfacial sheath (−9.65°C). In these systems the microdroplets may be considered as oil spheres encapsulated by an interfacial sheath of constant interfacial composition.

41159 Comparison of catalysts derived from oxidation of Ru_3Th_7 with impregnated Ru/ThO_2 catalysts. Huang, Chenshi (Univ. of Pittsburgh, PA (USA)); Houalla, M.; Hercules, D.M.; Kibby, C.L.; Petrakis, L. *Journal of Physical Chemistry (USA),* 93(11): 4540-4544 (1 Jun 1989).

Ruthenium-thoria catalysts, prepared either by oxidation of Ru_3Th_7 intermetallic or impregnation of high surface area ThO_2 with $Ru(NO)(NO_3)_3$, were characterized by ESCA, ISS, X-ray diffraction (XRD), chemisorption, and gravimetric measurements.

XRD and gravimetric analysis indicated that the intermetallic was extensively decomposed by oxidation at 350°C. ESCA and ISS Ru/Th intensity ratios for the intermetallic-derived catalyst were significantly lower than those obtained for the supported catalyst. This suggests a relative surface enrichment of Th in the alloy-derived catalyst. The catalysts were tested for CO hydrogenation. The turnover frequency of the catalyst derived from Ru_3Th_7 was 2 orders of magnitude higher than that of the catalyst prepared by impregnation. Exceptionally high methane selectivity was observed for the intermetallic-derived catalyst. The activity and selectivity data are discussed in terms of the reported structure sensitivity of the CO hydrogenation reaction and the differences in surface structures between the two types of catalysts.

41160 Dissociation dynamics of methanol clusters following multiphoton ionization. Morgan, S. (Pennsylvania State Univ., University Park (USA)); Castleman, A.W. Jr. *Journal of Physical Chemistry (USA)*, 93(11): 4544-4550 (1 Jun 1989).

Following multiphoton ionization (MPI), neutral methanol clusters are found to undergo a well-known ion-molecule reaction which leads to the production of protonated clusters. Evaporative dissociation rates of the cluster ions are measured for sizes ranging from the dimer to the 21-mer following MPI. There is a general trend of the rates decreasing with time after the initial ionization event in accordance with the evaporative ensemble model. Rates measured at long times after ionization display a consistent trend of increasing with cluster size. These findings are shown to be in accord with statistical considerations of evaporative unimolecular dissociation. Collision-induced-dissociation cross sections are found to generally increase with size; the finding of a local minimum in the value for $H^+(CH_3OH)_3$ is in agreement with predictions of its structure. Finally, through a combination of unimolecular evaporative and collision-induced-dissociation processes, as many as five methanol monomers are found to be lost from a cluster as small as $H^+(CH_3OH)_7$.

41161 Reaction mechanisms for the photocatalytic isomerization and hydrogenation of cis-2-butene over TiO_2. Kodama, Sukeya (Univ. of Osaka Prefecture, Sakai (Japan)); Yagi, Shinji. *Journal of Physical Chemistry (USA)*, 93(11): 4556-4561 (1 Jun 1989).

Photocatalytic isomerization and hydrogenation of cis-2-butene over TiO_2 and water-adsorbed TiO_2 were investigated. The reaction products were 1-butene and trans-2-butene on TiO_2 and were CH_4, C_2H_6, C_3H_8, n-C_4H_{10}, 1-butene, and trans-butene on water-adsorbed TiO_2. The formation amounts of these products were observed as functions of the reaction time and the light intensity. The initial rates (R^0) in 10^{-9} mol s^{-1} units, measured as a function of the relative light intensity (I_r), were R^0 (1-C_4H_8) = $6.09I_r + 1.21I_r^{\frac{1}{2}}$ and R^0(trans-2-C_4H_8) = $3.39I_r + 3.35I_r^{\frac{1}{2}}$ on TiO_2 and $R^0(CH_4) = 0.0087I_r$, R^0 (C_2H_6) = $0.236I_r$, R^0(n-C_4H_{10}) = $0.045I_r$, R^0 (1-C_4H_8) = $2.23I_r^{\frac{1}{2}}$, and R^0(trans-2-C_4H_8) = $2.45I_r^{\frac{1}{2}}$ on water-adsorbed TiO_2. No C_3H_8 as a primary product was found. From these results, it was found that the reaction modes of four kinds exist on the photocatalytic isomerization of cis-2-butene over TiO_2 and the overall isomerization rate on TiO_2 is about 50 times faster as compared with the total hydrogenation rate to CH_4, C_2H_6, and n-C_4H_{10} on water-adsorbed TiO_2 at I_r = 1. Reaction mechanisms in which Ti^{3+} and O^- for the isomerization to trans-2-butene depending on I_r; Ti^{3+}, O^-, and OH^- for the isomerization to 1-butene depending on I_r; OH for the isomerizations to 1-butene and trans-2-butene depending on $I_r^{\frac{1}{2}}$; OH and H for the hydrogenolyses to CH_4 and C_2H_6; and 2H for the hydrogenation to n-C_4H_{10} are concerned in their formations were postulated.

41162 Novel phase behavior in three-component oil-water-surfactant systems. A truncated isotropic channel in the oil-rich regime. Findenegg, G.H. (Ruhr-Universitaet Bochum (Germany, F.R.)); Hirtz, A.; Rasch, R.; Sowa, F. *Journal of Physical Chemistry (USA)*, 93(11): 4580-4587 (1 Jun 1989).

The phase behavior of three-component systems of the type water + hydrocarbon + poly(oxyethylene) alkyl ether (C_8E_4 and $C_{10}E_5$) has been studied at temperatures below the phase inversion. A narrow one-phase region was found in the oil-rich corner, which intrudes into the central miscibility gap between water and oil. At low temperatures the molar ratio of water and surfactant in this phase corresponds to two water molecules per oxyethylene group of the surfactant, and thus this phase may represent a hydrate strongly swollen with oil. As the temperature is raised, this region of one-phase stability becomes separated from the main one-phase region at higher surfactant concentrations and shrinks to a point at which this phase decomposes into two other liquid phases at a temperature T_{max}. Below this temperature the one-phase region is connected with two narrow three-phase regions, one of which disappears at a lower critical end point while the other extends to much lower temperatures. Measurements of the densities, viscosities, and interfacial tensions at three-phase coexistence are also presented and are consistent with the proposed phase diagram.

41163 Relation between phase diagram, crystallization, and optical properties of cyanine dye/stearic acid mixed monolayers. Duschl, C. (Max-Planck-Institut fuer Polymerforschung, Mainz (Germany, F.R.)); Kemper, D.; Frey, W.; Meller, P.; Ringsdorf, H.; Knoll, W. *Journal of Physical Chemistry (USA)*, 93(11): 4587-4593 (1 Jun 1989).

The phase behavior of cyanine dye monolayers mixed with stearic acid as cosurfactant was investigated at various mole fractions, x, by recording pressure-area isotherms at the water-air interface. The resulting pressure-composition phase diagram shows a eutectic behavior with mixed crystal formation. In the miscibility gap ranging from $x \approx 0.3$ to $x \approx 0.95$ above the eutectic pressure π_e = 40 mN·m^{-1} the two coexisting crystal modifications are characterized (among other techniques) by fluorescence microscopy and, after transfer to a suitable substrate, by electron diffraction. The dye-rich (x = 0.95) crystals show all the characteristic features of the brick-stone arrangement proposed for the molecular packing of the dye chromophores in J aggregates. The x = 0.3 phase boundary with a distinctly different crystal habit is stabilized by the areal match between the chromophore headgroups and the densely packed hydrocarbon chains. These thermodynamic and structural data are discussed in relation to the optical properties of the J-band aggregates.

41164 Structure and dissociation mechanisms of methanol in ZSM-5 zeolite. Vetrivel, R. (Univ. of Keele, Staffordshire (England)); Catlow, C.R.A.; Colbourn, E.A. *Journal of Physical Chemistry (USA)*, 93(11): 4594-4598 (1 Jun 1989).

The authors use a combination of lattice simulation calculations and ab initio quantum mechanical techniques to study the adsorption behavior of methanol in ZSM-5. We locate the low-energy adsorption sites for the methanol molecule inside the pores of the ZSM-5 zeolite using lattice simulation techniques. Electronic structure calculations are carried out on the cluster representing the adsorption complex, while an array of point charges are included to represent the long-range electrostatic effects. We propose a dissociation mechanism for methanol at the Broensted acid site of this zeolite.

41165 Observation of cyanate and isocyanate surface species during the reaction of ammonia and carbon monoxide over supported rhodium. Paul, D.K. (Auburn Univ., AL (USA)); McKee, M.L.; Worley, S.D.; Hoffman, N.W.; Ash, D.H.; Gautney, J. *Journal of Physical Chemistry (USA)*, 93(11): 4598-4603 (1 Jun 1989).

The reaction of CO with NH_3 over preoxidized Rh/SiO_2 has been studied by infrared spectroscopy to detect surface intermediates. Two of the surface species having infrared bands at 2172 and 2225 cm^{-1} have been identified as RhNCO and RhOCN, respectively. This is likely the first observation of these two surface species simultaneously on a supported transition-metal catalyst. High-quality ab initio computations have been employed to aid in the band assignments.

41166 ESR and optical evidence on formation on the $Cl^-...CCl_3^+$ ion pair in 3-methylpentane matrices γ-irradiated at 77 K. Truszkowski, Stanislaw (Hiroshima Univ. (Japan)); Ichikawa, Takahisa. *Journal of Physical Chemistry (USA)*, 93(11): 4522-4526 (1 Jun 1989).

The well-known absorption band at 470 nm in CCl_4-alkane systems is investigated. The results obtained are as follows: (1) The absorption band due to the radical cation of 5-methyldecane

($5MD^+$) in 5MD-CCl_4-3MP systems converts into the 470-nm band. (2) In the conversion, the positive charge of the $5MD^+$ reacts with the unpaired electron of the CCl_3• radical. (3) $CBrCl_3$ and CCl_3F in 3MP glasses produce the absorption bands at 460 and 438 nm, respectively, and the nature of these bands is the same with that of the 470-nm band in the all points examined. Results 1 and 2 lead to the formation of CCl_3^+ cations from $CBrCl_3$ and CCl_2F^+ cations from CCl_3F. It is evident that the band shift observed in the case of $CBrCl_3$ is not attributable to the free ions CCl_3^+ nor to the solvent-separated ion pairs Br^- solvent CCl_3^+ but to the formation of charge-transfer contact ion pairs $Br^-...CCl_3^+$. Therefore, it is concluded that CCl_4 and CCl_3F in 3MP produce $Cl^-...CCl_3^+$ and $Cl^-...Cl_2F^+$, respectively. We also obtain the results that $CBrF_3$, $CClF_3$, and CCl_2F_2 in 3MP glasses yield the corresponding radical anions with absorption bands at 314, 300, and 314 nm, respectively, and that these radical anions are neutralized with the migrating positive charges of the $5MD^+$ formed.

41167 Two innocent chemists look at cold fusion. Walling, C. (Univ. of Utah, Salt Lake City (USA)); Simons, J. *Journal of Physical Chemistry (USA),* 93(12): 4693-4697 (15 Jun 1989).

The authors propose that the large energy release reported in the experiments of Fleischmann, Pons, and Hawkins may be the consequence of ^2H fusion accelerated through screening by neighboring heavy electrons with mass $m^* \approx 10$ electron masses. The presence of the Pd lattice may also accelerate the radiationless relaxation (RR) of the transient excited $^4He^*$, perhaps by an internal-conversion-like process. If RR exceeds the rate of fragmentation of $^4He^*$, this can explain why the bulk of the energy is released as heat rather than via neutron and tritium production. Symmetry considerations show that low-energy fusion can lead to different product channel branching ratios than are observed in high-energy experiments and may allow RR rates to outstrip fragmentation rates. Our analysis also suggests that the rate of $^1H + ^2H$ fusion may be comparable to or even in excess of that of $^2H + ^2H$ fusion in the Pd lattice, so that fusion might even be observed in water of natural abundance deuterium content.

41168 Dynamics and ordering of intercalated water in layered metal hydroxides. Marcelin, G. (Univ. of Pittsburgh, PA (USA)); Stockhausen, N.J.; Post, J.F.M.; Schutz, A. *Journal of Physical Chemistry (USA),* 93(11): 4646-4650 (1 Jun 1989).

The interaction of intercalated water molecules with Mg-Al-NO_3 double-metal hydroxides has been studied by using NMR spectroscopy. The water molecules are hydrogen-bonded to the hydroxyl groups in the layers causing them to be oriented perpendicular to the plane of the layers, while retaining their translational mobility. The strength of the bonding between the interlayer water and the layers, as evidenced by the temperature at which a motionally averaged Pake doublet first appears, is related to the interlayer spacing available for intercalation of the guest water molecules.

41169 The chemical and physical properties of electrochemically prepared polyaniline p-toluenesulfonates. Choi, Kyung Moon (Yonsei Univ., Seoul (Korea)); Kim, Kue Hong; Choi, Jae Shi. *Journal of Physical Chemistry (USA),* 93(11): 4659-4664 (1 Jun 1989).

Polyaniline p-toluenesulfonate (PATS) was synthesized by the electrochemical technique from 0.2 M aniline in 1:99 water/acetonitrile solution containing 0.1 M tetraethylammonium p-toluenesulfonate (TEATS) as supporting electrolyte. Following the polarographic and cyclic voltammetry measurements, the values of the half-wave potential, transfer coefficient and number of electrons were measured to be 516 mV, 0.49, and 1, respectively. The results of TGA and DSC showed the the weight loss was most rapid in the temperature range from 553 to 653 K, and the maximum value of the reaction rate was 0.23 mg/min at 611 K. The electrical conductivity of PATS was measured in the temperature range from 123 to 298 K. From the plot of resistivity vs 1/T, E_a was obtained to be 0.038 eV. From the temperature dependence of the conductivity and ESR measurements, it is suggested that the conduction mechanism for PATS is possibly a small polaron hopping conduction.

41170 Electron spin-echo and electron spin-resonance studies of cupric ion-adsorbate interactions in hydrogen, sodium, potassium, and calcium mordenite. Sass, C.E. (Univ. of Houston, TX (USA)); Kevan, L. *Journal of Physical Chemistry (USA),* 93(11): 4669-4674 (1 Jun 1989).

The interaction between cupric ion and both polar and nonpolar adsorbates in mordenite-type zeolite was studied as a function of the cocation. Cu^{2+} was able to coordinate to three molecules of either water or ammonia in H-mordenite but to only two molecules of each in Na-, K-, or Ca-mordenite. These results suggest that Cu^{2+} is located in a site off the main channel in H-mordenite but in a highly twisted 8-ring site in the other forms of mordenite. Evidence based on adsorption and activation studies also suggests that some Cu^{2+} is located in an additional, unidentified site in H-mordenite. These results are compared to the results of similar studies of cupric ion in zeolite ZSM-5.

41171 Ion-molecule chemistry within triply charged ammonia clusters. Peifer, W.R. (State Univ. of New York, Buffalo, NY (USA)); Coolbaugh, M.T.; Garvey, J.F. *Journal of Physical Chemistry (USA),* 93(12): 4700-4703 (15 Jun 1989).

The authors present in this communication the first observation of intramolecular ion-molecule reactions within triply charged clusters produced via electron impact ionization of neat beams of ammonia molecules. The fragmentation pattern strongly suggests that reactions occurring within these triply charged clusters are similar to those previously observed for singly and doubly charged ammonia clusters. This behavior implies that these cluster ions consist of three singly charged ammonia cations which react separately within the bulk neutral cluster. That is, either one, two, three, or none of the ammonia cations may react with the solvating neutrals within the cluster. We also report for singly charged ammonia clusters the observation that extensive fragmentation can occur within the cluster producing ions with the empirical formulas of $(NH_3)_{n-1}N^+$ and $(NH_3)_{n-1}NH^+$.

41172 Kinetics of the reaction of CH_3S with O_3 at 298 K. Tyndall, G.S. (National Oceanic and Atmospheric Administration, Boulder, CO (USA)); Ravishankara, A.R. *Journal of Physical Chemistry (USA),* 93(12): 4707-4710 (15 Jun 1989).

Laser-induced fluorescence was used to detect CH_3S radicals in the laser flash photolysis of CH_3SH-O_3-H_2O-He (SF_6) mixtures. Evidence was found for a reaction between CH_3S and O_3, with a rate coefficient of $(4.1 \pm 2.0) \times 10^{-12}$ cm^3 $molecule^{-1}$ s^{-1}. The yield of CH_3S from the reaction OH + CH_3SH was determined to be 1.1 ± 0.2. Our results suggest that the $CH_3S + O_3$ reaction could be the major sink for CH_3S in the atmosphere.

41173 Time-resolved electron spin resonance study of the nonphosphorescent triplet state of trans-diazastilbene. Yagi, Mikio (Yokohama National Univ. (Japan)); Mikuni, Kenji; Takano, Keiichi; Shioya, Yasushi; Higuchi, Jiro. *Journal of Physical Chemistry (USA),* 93(12): 4714-4715 (15 Jun 1989).

Time-resolve ESR spectra have been observed for the lowest triplet (T_1) state of trans-diazastilbene (trans-4,4′-dipyridylethylene, trans-DPE) in EPA rigid glass and in stretched poly(vinyl alcohol) films at 77 K. Zero-field splitting parameters and relative populating rate constants of triplet spin sublevels are determined. These values indicate that the distortion from the planar structure by the rotation around the central C=C bond is small for the T_1 state of trans-DPE in rigid matrices at 77 K.

41174 Spectroscopy of C-H stretching overtones in dimethylacetylene, dimethylcadmium, and dimethylmercury. Manzanares I., C. (Northwestern Univ., Evanston, IL (USA)); Yamasaki, N.L.S.; Weitz, E. *Journal of Physical Chemistry (USA),* 93(12): 4733-4741 (15 Jun 1989).

The overtone spectra of a number of C-H stretching vibrations of dimethylacetylene, dimethylcadmium, and dimethylmercury were obtained by using intracavity dye laser photoacoustic spectroscopy. Transitions corresponding to the $\Delta\nu = 5$, 6, and 7 overtones of the C-H stretch are assigned by using the local-mode model. In addition, a number of local-mode-normal-mode combination bands have been identified. Local-mode harmonic frequencies (ω_e) and anharmonicities ($\omega_e x_e$) are obtained from Birge-Sponer plots. The line widths of the pure local-mode transitions are analyzed in terms of possible resonances with local-mode-normal-mode combination bands. Line widths in this series of compounds are compared to line widths in the $M(CH_3)_4$ and $M(CH_3)_3$ series.

41175 Kinetics and product studies of the reaction ClO + BrO using discharge-flow mass spectrometry. Friedl, R.R. (California Institute of Technology, Pasadena (USA)); Sander, S.P. *Journal of Physical Chemistry (USA),* 93(12): 4756-4764 (15 Jun 1989).

The kinetics and product branching ratios of the BrO + ClO reaction have been characterized at 1 Torr of total pressure over the temperature range 220-400 K with the technique of discharge-flow mass spectrometry. The measured overall reaction rate coefficient is $k_1 = (4.70 \pm 0.50) \times 10^{-12} \exp[(320 \pm 40)/T]$ cm^3 molecule^{-1} s^{-1}. Three product channels, identified as Br + ClOO (1a), Br + OClO (1b), and BrCl + O_2 (1c) have been quantified: $k_{1a} = (2.9 \pm 1.0) \times 10^{-12} \exp[(217 \pm 50)/T]$ cm^3 molecule^{-1} s^{-1}; $k_{1b} = (1.6 \pm 0.4) \times 10^{-12} \exp[(426 \pm 50)/T]$ cm^3 molecule^{-1} s^{-1}; $k_{1c} = (5.8 \pm 2.0) \times 10^{-13} \exp[(168 \pm 50)/T]$ cm^3 molecule^{-1} s^{-1}. On the basis of these results, it is argued that the reaction mechanism for ClO + BrO, like those of halogen monoxide self-reactions, involves metastable intermediate formation. In addition, emphasis is placed on the significant impact of these results on current models of stratospheric ozone depletion, which neglect channel 1c and the temperature dependence of k_1.

41176 Kinetics and product studies of the reaction ClO + BrO using flash photolysis-ultraviolet absorption. Sander, S.P. (California Institute of Technology, Pasadena (USA)); Friedl, R.R. *Journal of Physical Chemistry (USA),* 93(12): 4764-4771 (15 Jun 1989).

The flash photolysis-ultraviolet absorption method has been used to study the BrO + ClO reaction over the pressure range 50-700 Torr and temperature range 220-400 K. The rate constant for the overall reaction is given by $k_1 = (6.1 \pm 1.2) \times 10^{-12} \exp[(240 \pm 60)/T]$ cm^3 molecule^{-1} s^{-1} ($\pm 2\sigma$ error limits). Branching ratios for the reaction channel forming OClO were determined at 220 and 209 K and found to be 0.68 ± 0.10 and 0.59 ± 0.10, respectively. Absolute UV absorption cross sections for ClO and BrO were determined as a function of temperature at the peaks of the 12-0 and 7-0 bands. In order to more fully understand the reaction mechanism used in the BrO + ClO study, the reactions Br + $Cl_2O \rightarrow$ ClO + BrCl and Cl_2O + hν → products were examined. The Arrhenius expression for the Br + Cl_2O reaction was found to be $k_3 = (2.1 \pm 1.8) \times 10^{-11} \exp[-(520 \pm 260)/T]$ cm^3 molecule^{-1} s^{-1} ($\pm 2\sigma$) over the temperature range 220-298 K. The quantum yield for the production of atomic oxygen from broad-band Cl_2O photolysis ($\lambda >$ 180 nm) was found to be 0.25 ± 0.05.

41177 Recombination of methyl radicals: Ab initio potential and transition-state theory calculations. Darvesh, K.V. (Dalhousie Univ., Halifax, Nova Scotia (Canada)); Boyd, R.J.; Pacey, P.D. *Journal of Physical Chemistry (USA),* 93(12): 4772-4779 (15 Jun 1989).

Ab initio calculations employing the configuration interaction method have been applied to the recombination of methyl radicals. The methyl radicals have been restricted to a planar equilateral triangular geometry, but the carbon-carbon distance and five angles defining the mutual orientation of the radicals have been varied. Attractions between the radicals appear to be dominated by σ bonding between the singly occupied orbitals on the two radicals, although π bonding also appears to contribute in some orientations. At short distances, repulsive forces between atoms on adjacent radicals are important. All these interactions have been represented by simple expressions, which have been combined to represent the potential energy as a function of the six coordinates varied. Eight parameters in the potential energy expression have been adjusted by least squares, fitting the ab initio points to within 1.4 kJ mol^{-1}. Canonical variation transition-state theory calculations have been performed on the resulting potential energy surfaces. A Monte Carlo methods was used to integrate the Boltzmann factor over the five angles. The critical distance or bottleneck was found to decrease from a carbon-carbon distance of 4.0 Å at 200 K to 2.7 Å at 2000 K. The rate constant is 5×10^{10} L mol^{-1} s^{-1} at 300 K and decreases with increasing temperature. Recent experimental results parallel the theoretical ones but are 15-30% slower.

41178 Large magnetic field effect on the decay rates of triplet hydrocarbon diradicals. Wang, J. (Columbia Univ., New York, NY (USA)); Doubleday, C. Jr.; Turro, N.J. *Journal of Physical Chemistry (USA),* 93(12): 4780-4782 (15 Jun 1989).

Intersystem crossing rate constants, k_{ISC}, of triplet 1,n-diphenyl 1,n-diyl diradicals (n = number of carbons in diradical chain) generated by type I photolyses of α,α'-diphenylcycloalkanones were measured in an external magnetic field H variable up to 2 kG. No magnetic field effect was observed for n = 4 and 5, but for n = 9, 11, and 14, k_{ISC} first increased then decreased as H was increased. For n = 11 and 14, the value of k_{ISC} decreased to an apparent asymptotic value at high field equal to 0.17 and 0.07, respectively, of the value of k_{ISC} at H = O. For diradicals with $n \geq 9$, it is proposed that, at H = O, electron-nuclear hyperfine coupling is the only important ISC mechanism, that at H = 2 kG electronic spin-lattice relaxation is the major ISC mechanism, that the three triplet magnetic sublevels do not equilibrate during the diradical lifetime, and that one of the outer two triplet magnetic sublevels is preferentially populated initially.

41179 Laser flash photolysis of chlorine dioxide: Formation and ultraviolet absorption spectrum of Cl_2O_3. Colussi, A.J. (National Research Council of Canada, Ottawa, Ontario (Canada)); Redmond, R.W.; Scaiano, J.C. *Journal of Physical Chemistry (USA),* 93(12): 4783-4785 (15 Jun 1989).

The kinetics of ClO_2 photodecomposition in trichlorofluoromethane solutions induced by 337.1-nm pulses were investigated under various experimental conditions. Instantaneous photochemical bleaching is followed by a slower bleaching which follows pseudo-first-order kinetics and leads to the formation of a long-lived transient species absorbing up to 330 nm with $\lambda_{max} \approx 280$ nm. At high concentrations of ClO_2 identical amounts of chlorine dioxide are consumed in both stages, revealing that the latter involves stoichiometric reaction of an initially formed intermediate with excess ClO_2. Addition of tetramethylethylene, a very efficient oxygen atom quencher, had no detectable effect on the kinetics of ClO_2 decay. The intermediate is therefore identified as ClO and the new species as Cl_2O_3, chlorine sesquioxide, formed by reaction 5: ClO + $ClO_2 \rightarrow Cl_2O_3$.

41180 Reaction between the amidogen radical, NH_2, and molecular oxygen in low-temperature matrices. Crowley, J.N. (Univ. of East Anglia, Norwich (England)); Sodeau, J.R. *Journal of Physical Chemistry (USA),* 93(12): 4785-4790 (15 Jun 1989).

The reaction between NH_2 and O_2 has been examined in a low-temperature matrix for the first time. Results from a series of experiments employing isotopically substituted ammonia and oxygen indicate that the primary reaction products are HONO and H atoms. A reaction mechanism is proposed that involves the intermediacy of the aminoperoxy radical, NH_2OO, which is stabilized by the low-temperature/high-pressure environment of the matrix before undergoing intramolecular decomposition or reaction with oxygen.

41181 Triplet photophysical properties of poly(2-vinylnaphthalene) and poly(N-vinylcarbazole) solid films in a low-temperature regime. Chakraborty, D.K. (Univ. of Nevada, Reno (USA)); Burkhart, R.D. *Journal of Physical Chemistry (USA),* 93(12): 4797-4802 (15 Jun 1989).

The delayed fluorescence intensity from solid films of poly(2-vinylnaphthalene) (P2VN) and poly(N-vinylcarbazole) (PVCA) both yield maxima below 77 K when plotted as a function of temperature. For PVCA, earlier work had already established the existence of one maximum at 200 K along with a minimum at 145 K. Thus, the new maximum observed here near 40 K is the third extremum found for this polymer verifying earlier predictions of its existence. For P2VN a maximum in the delayed fluorescence-temperature profile is found near 55 K but no others are observed up to ambient temperature. The major source of delayed fluorescence intensity in both polymers is thought to arise from triplet-triplet hetero annihilations involving a mobile triplet exciton, T_m, and a shallow-trapped one, T_s. The increase in DF intensity from the lowest temperature up to the low-temperature maximum is due to an increasing rate of T_m mobility. The maximum occurs at a temperature such that the rate of thermally induced detrapping of T_s approaches that of competing processes for its relaxation to the ground state. A similar mechanism is proposed for PVCA. This mechanism is consistent with the observation that the low-temperature maxima disappear at

long times after the excitation pulse and that the temperature corresponding to the maximum increases as the delay time decreases.

41182 **Benzylbromocarbene: Absolute rate constant for 1,2-hydrogen migration and ambiphilicity.** Bonneau, R. (Universite de Bordeaux, Talence (France)); Liu, M.T.H.; Suresh, R.V. *Journal of Physical Chemistry (USA),* 93(12): 4802-4806 (15 Jun 1989).

Laser flash photolysis studies of the reaction of benzylbromocarbene with pyridine enables the determination of the absolute rate constant for the 1,2-hydrogen migration in benzylbromocarbene. Thus, $k = 5.6 \times 10^7/s^{-1}$ at 25°C. Relative reactivities of benzylbromocarbene toward electron-poor and electron-rich alkenes indicate that the carbene is ambiphilic. The present results are consistent with a mechanism involving a carbene-alkene intermediate.

41183 **Collinear diatomic molecule-diatomic molecule collisions treated in the sudden approximation.** Tellez, S. (Univ. of Nebraska, Omaha (USA)); Hays, R.; Pfeffer, G.A. *Journal of Physical Chemistry (USA),* 93(12): 4810-4815 (15 Jun 1989).

Collinear collisions of $H_2 + Cl_2$ and $O_2 + Cl_2$ at 0.5, 1.0, 1.5, and 2.0 eV have been studied in the vibrational sudden approximation (VSA). The VSA applied only to molecule 2, the Cl_2, gives good transition probabilities for $H_2 + Cl_2$ but not for $O_2 + Cl_2$. When the probabilities are in the range 0.1-1.0, the VSA performs excellently; with smaller probabilities, the VSA is still in qualitative agreement with exact results. The choices for n_2, the arbitrary parameter introduced in the VSA, which give the most accurate results are $n_2 = n_2'$ (the final value of n_2) or $n_2 = (n_2 + n_2')/2$ (the average of the initial and final values of n_2); either choice is acceptable although n_{2s} is more appropriate for larger Δn_2. The VSA reduces the computer execution time by at least an order to magnitude compared to the exact method. The VSA applied to both colliding molecules is found to be unsatisfactory.

41184 **Photocatalytic activities of microcrystalline TiO_2 incorporated in sheet silicates of clay.** Yoneyama, Hiroshi (Osaka Univ. (Japan)); Haga, Shigeo; Yamanaka, Shoji. *Journal of Physical Chemistry (USA),* 93(12): 4833-4837 (15 Jun 1989).

Photochemical and photocatalytic properties of microcrystalline TiO_2 incorporated in the interlayer space of montmorillonite were investigated in reference to those of TiO_2 powder particles which were prepared by agglomeration of a titania sol that was used in the preparation of the titania-pillared clay. The pillared TiO_2 microcrystallites having ca. 15-Å pillar height showed a ca. 0.58-eV blue shift in its absorption and fluorescence spectra compared with those of the TiO_2 particles, exhibiting the quantum size effect. The excited electronic states of the pillared TiO_2 were determined to be 0.36 V more negative than that of the TiO_2 powder particles. Photocatalytic activities of the pillared TiO_2 were greater than those of the TiO_2 powder particles for decomposition of 2-propanol to give acetone and hydrogen and of n-carboxylic acids with up to eight carbons (from acetic acid to caprylic acid) to give the corresponding alkanes and carbon dioxide, though the pillared TiO_2 exhibited lower activities for decomposition of capric acid, having 10 carbons in a molecule.

41185 **Solid-state ^{113}Cd nuclear magnetic resonance study of exchanged montmorillonites.** Bank, S. (State Univ. of New York, Albany (USA)); Bank, J.F.; Ellis, P.D. *Journal of Physical Chemistry (USA),* 93(12): 4847-4855 (15 Jun 1989).

The solid-state ^{113}Cd nuclear magnetic resonance of cadmium adsorbed on montmorillonite was investigated. An analysis of three montmorillonite samples and a brief comparison with other clays are included. The spectra contain cadmium oxoanion components of differing line widths with differential sensitivities to preparation conditions. Echo train experiments at various temperature and τ delays indicate that the line widths are governed by dynamic processes rather than chemical shift dispersion. These same experiments show the heterogeneity of the cadmium sites. Included in the study are the effects of pH variation, exchanged clay form, pretreatment with alginic and humic acids, and air- and freeze-drying. These results are described in terms of ions in different environments and ion motion. For montmorillonite some of these sites are considered to be near iron in the octahedral layer. The interlayer ion diffusion is related to metal ion transport in clay layers and the potential consequences of migration.

41186 **Microemulsifying polar oils.** Wormuth, K.R. (Univ. of Washington, Seattle (USA)); Kaler, E.W. *Journal of Physical Chemistry (USA),* 93(12): 4855-4861 (15 Jun 1989).

The phase behavior and microstructure of $C_{12}E_6$/ether oil/water mixtures have been examined systematically as a function of increasing oil polarity. As the ratio of ether linkages to methylene groups of the ether oils is increased, the oils become more water soluble and more polar (less hydrophobic). When ethylene glycol dibutyl ether is replaced with the more polar ethylene glycol diethyl ether in $C_{12}E_6$/ether oil/water mixtures, the three-phase region shrinks and disappears: the system bypasses a tricritical point. Simultaneously, the liquid crystalline region retreats to higher surfactant concentration, and light and x-ray scattering measurements indicate that the microstructure decreases dramatically in size. According to small-angle x-ray scattering results, $C_{12}E_6$/ethylene glycol diethyl ether/water mixtures retain an interface between oil-like and water like domains. However, since the ether is highly soluble in the water and interface domains, the microstructure is diffuse.

41187 **Capillary rise in thin porous media.** Marmur, A. (Technion-Israel Institute of Technology, Haifa (Israel)). *Journal of Physical Chemistry (USA),* 93(12): 4873-4877 (15 Jun 1989).

A theory for the equilibrium capillary rise inside a thin porous medium is presented. It is shown that the height of rise depends on the thickness of the medium and is lower than the corresponding value for a infinitely thick slab. The extent of deviation is shown to depend on all the parameters which characterize the system. For high true contact angles, the capillary rise in a thin porous medium may be only a very small fraction of the value for a thick one. This phenomenon is explained in terms of the reexposure effect, which stems from the exposure of the liquid rising inside the porous medium to the outside fluid, through the pores in the side surfaces. A symmetry with respect to the axis of 90° for the true contact angle is identified, so that the results for capillary rise can be also applied to capillary depression.

41188 **Autoacceleration and kinetics of electrochemical polymerization of aniline.** Wei, Yen (Drexel Univ., Philadelphia, PA (USA)); Sun, Yan; Tang, Xun. *Journal of Physical Chemistry (USA),* 93(12): 4878-4881 (15 Jun 1989).

A convenient method is presented for determining the rate of polyaniline formation in the electrochemical polymerization of aniline in aqueous HCl solution utilizing cyclic potential sweep techniques. In this method, the mass of polyaniline deposited on a platinum electrode is correlated with the polymer anodic peak current that is recorded during the polymerization. The rates of polymer deposition were therefore monitored by the increases in the anodic peak current at various concentrations of aniline. A kinetic expression obtained for the polymerization accounts well for the autoacceleration process in the electrochemical polymerization of aniline and supports the mechanism of polymerization in which monomeric aniline is incorporated in the growing polymer.

41189 **Role of defects in radiation chemistry of crystalline organic materials. 1. ESR evidence for electron trapping in the mixed crystals of binary n-alkanes at low temperatures.** Muto, Hachizo (Government Industrial Research Institute, Nagoya (Japan)); Nunome, Keichi; Toriyama, Kazumi; Iwasaki, Machio. *Journal of Physical Chemistry (USA),* 93(12): 4898-4903 (15 Jun 1989).

An ESR study has been made on the electron stabilization in the mixed crystals of binary n-alkanes irradiated at 77 and 4 K, as the first step in understanding the role of defects in radiation chemistry. Evidence has been obtained to show that the radiation-induced electrons are trapped in the mixed crystals in contrast to the absence of trapped electrons in the neat n-alkanes, together with the following results on the trapping site. The ESR line width (ΔH_{msl}) of trapped electrons (reflecting the effective defect size) correlates with the chain length difference (Δn_c) between two n-alkanes. An increase of Δn_c gives a higher yield of the trapped electrons probably because of a stabilization due to an expansion of the defect size. The number of defects accessible to the electrons depends on the crystal structures, being slightly larger in triclinic crystal than in orthorhombic crystals. The effect of deuteriation of the molecules on ΔH_{msl} in addition to the above results suggests that the trapping

site is a crystalline lattice defect created by inhomogeneous contacts of the different chain length molecules at the layer boundary and that preexisting defects such as voids are necessary for electrons to be trapped in crystalline n-alkanes.

41190 Surface reactions of hydrocarbons as a probe for the characterization of $RhCu/SiO_2$ catalysts. Coq, B. (ENSCM, Montpellier (France)); Dutartre, R.; Figueras, F.; Rouco, A. *Journal of Physical Chemistry (USA)*, 93(12): 4904-4908 (15 Jun 1989).

$RhCu/SiO_2$ catalysts of various compositions were prepared from nitrate precursors and characterized by transmission electron microscopy and chemisorption. The catalytic properties were determined in a flow microreactor, at low conversion, for the hydrogenation of benzene, poisoned or not by thiophene, and the conversion of a series of alkanes: n-hexane (n-H), 2-methylpentane (2MP), 2,2-dimethylbutane (22DMB), 2,2,3,3-tetramethylbutane (2233TMB), methylcyclopentane (MCP). The conversion of alkanes at 493 K gives mainly hydrogenolysis of C-C bonds. The rate of cleavage depends on the degree of substitution of the carbon atoms and on the Cu/Rh ratio. Cu inhibits all reactions; however, the magnitude of this effect depends on the structure of the reactant. The comparison of the alloying effect with the effect of Rh particle size on the same set of reactions (Coq et. al.) shows that on the one hand 2233TMB has a lower sensitivity to alloying than to particle size; the selectivity to i-C_4 remains high and characteristic of large particles of rhodium up to Cu/Rh = 1. On the other hand n-H, 2MP, and MCP are more sensitive to alloying than to change of particle size. These results suggest that Cu occupies preferentially the sites of low coordination, edges, and corners, and Rh the sites of high coordination on dense planes. This set of reactions, therefore, probes the extent of surface segregation on RhCu-supported particles.. By addition of thiophene a monotonic decrease of activity in the hydrogenation of benzene occurs due to sulfurization of the surface. The rate of poisoning is faster when the local density of states at the Fermi level of Rh surface atoms is higher. Dilution of Rh by Cu has little effect on the thioresistance which remains low even at high Cu content. Very likely little electronic interaction occurs between Rh and Cu.

41191 An x-ray photoelectron study of metal clusters in zeolites. Andersson, S.L.T. (Lund Univ. (Sweden)); Howe, R.F. *Journal of Physical Chemistry (USA)*, 93(12): 4913-4920 (15 Jun 1989).

The adsorption and decomposition of the volatile carbonyl complexes $Mo(CO)_6$, $Fe(CO)_5$, $Co_2(CO)_8$, and $Co(CO)_3NO$ in various zeolites has been studied by XPS. $Mo(CO)_6$ produces highly dispersed zerovalent clusters in zeolites NaY, NaX, and KL, and a mixture of oxidized species in LaY. $Fe(CO)_5$ produces initially zerovalent clusters in NaY, but these migrate to the external surface on heating to higher temperatures. Migration of iron out of the zeolite is inhibited by exchanging divalent cations Co^{2+} and Ni^{2+} into the zeolite. $Co_2(CO)_8$ decomposes extensively on the external surface of NaY and NaX, but the mononuclear complex $Co(CO)_3NO$ is readily adsorbed into NaY; decomposition produces a mixtures of zerovalent and oxidized cobalt species.

41192 Effect of pressure on the solubilities of benzene and alkylbenzenes in water. Sawamura, Seiji (Ritsumeikan Univ., Kyoto (Japan)); Kitamura, Kiyoshi; Taniguchi, Yoshihiro. *Journal of Physical Chemistry (USA)*, 93(12): 4931-4935 (15 Jun 1989).

The solubilities of benzene, toluene, ethylbenzene, and n-propylbenzene in water were measured at 25°C at pressures to 400 MPa (100 MPa for benzene). The maxima in the solubilities are observed at 200, 150, and 140 MPa for toluene, ethylbenzene, and n-propylbenzene, respectively. The volume changes, $\Delta V°$, accompanying the solution are estimated at high pressures from the pressure dependences of the solubilities. The compressions of ethylbenzene, n-propylbenzene, and m-xylene were measured at 25°C up to 350 MPa with a mercury-trapped piezometer in order to estimate the molar volumes, V°, of the solutes. The partial molar volumes, V°, of benzene and alkylbenzenes in water at high pressures up to 400 MPa were estimated from the $\Delta V°$ and V°, and the isothermal partial molar compressibilities, $\beta_T° \equiv 1/V° (\delta V°/\delta P)_T$, were also determined. The $\beta_T°$ of ethylbenzene and n-propylbenzene at atmospheric pressure were -1.6×10^{-4} and -2.1×10^{-4} MPa^{-1}, respectively; these quantities became positive at ca. 50 MPa. The $\beta_T°$ for the other solutes were positive and decreased with increasing pressure. The compressibilities, β_h, of the hydration shells around the solutes were estimated by a model of the hydration state. The results suggest that the hydration shell is destroyed by compression and disappears above 100 MPa.

41193 Calculation of the thermodynamic properties of aqueous electrolytes to 1000°C and 5000 bar from a semicontinuum model for ion hydration. Tanger, J.C. IV (Lawrence Berkeley Lab., CA (USA)); Pitzer, K.S. *Journal of Physical Chemistry (USA)*, 93(12): 4941-4951 (15 Jun 1989). DOE Contract AC03-76SF00098.

A semicontinuum approach for prediction of standard-state Gibbs free energies of ionic hydration, Δ_hG, at high temperature steam conditions has been revised to permit predictions at temperatures from 0 to 1000°C and any pressure up to 5 kbar. The revised semicontinuum model provides for a more realistic identification of inner-shell and outer-shell contributions. The inner-shell term accounts for contributions to Δ_hG from the first six H_2O molecules of hydration. Inner-shell contributions are calculated by using available experimental equilibrium constants for successive ionic hydration reactions and an empirical parameter that represents the effective volume increment per H_2O of hydration. The outer-shell term accounts for contributions to Δ_hG from H_2O molecules outside the inner-shell region. Outer-shell contributions are obtained from the Born equation using the bulk solvent dielectric constant and an empirical parameter that represents the effective Born radius. The empirical parameters in the revised model are characterized in a manner that ensures reasonable consistency with experimental standard-state volumes and heat capacities for aqueous electrolytes. Calculations on alkali-metal halide and alkali-metal hydroxide electrolytes are considered, and the results for NaCl are used to illustrate the pressure and temperature behavior of standard-state properties. Evaluation of uncertainties in predicted values for Δ_hG supports application of the revised model for rough quantitative estimation of standard-state properties at supercritical conditions. The validity of the revised model at supercritical conditions is also supported by a comparison of calculated and experimental apparent molal heat capacities for NaCl.

41194 Fluorescence spectra of 7-azaindole in the sol-gel-xerogel stages of silica. Matsui, Kazunori (Kanto Gakuin Univ., Yokohama (Japan)); Matsuzuka, Tsuyoshi; Fujita, Hideo. *Journal of Physical Chemistry (USA)*, 93(12): 4991-4994 (15 Jun 1989).

The fluorescence spectra of 7-azaindole were studied in a mixed solution of $Si(OC_2H_5)_4$, H_2O, and ethanol, which reacts to form silica gel glass, i.e., porous SiO_2. Significant shift in the fluorescence (380-430 nm in λ_{max}) was observed, mainly during the gel-xerogel stages. Fluorescence, fluorescence excitation, and absorption spectra indicated that 7-azaindole forms a hydrogen-bonded complex with ethanol in the solution and finally forms a complex of stronger hydrogen bonds with silanol in the xerogel. They also show that the large shift in fluorescence is attributed not to the stabilization in the ground state but to that in the excited state. We consider the large shift in the fluorescence spectra can be explained by the interaction between the 7-azaindole complex with silanol and a larger number of polar silanol groups which surround the complex. In addition, fluorescence spectra reveal that a double proton transfer reaction occurs in the sol-gel stages and, possibly, in the xerogel.

41195 Infrared dichroic studies of polythiophenes. Hotta, Shu (Matsushita Electric Industrial Co., Ltd., Osaka (Japan)); Soga, Mamoru; Sonoda, Nobuo. *Journal of Physical Chemistry (USA)*, 93(12): 4994-4998 (15 Jun 1989).

Infrared dichroic spectra of the uniaxially drawn films of polythiophene and its 3-hexyl derivative, poly(3-hexylthiophene), are presented. The dichroic measurements were carried out using probe rays (incident perpendicular to the film plane) whose polarization plane lies either parallel or perpendicular to the drawn direction. For the neutral films of polythiophene and poly(3-hexylthiophene) the ring stretching mode, ν(ring), with the symmetric species of b_1 is strongly polarized along the drawn direction of the film, while the CH out-of-plane deformation mode, γ(CH), is highly polarized perpendicular to the drawn direction. The results of the dichroic measurements on the drawn films of partially

oxidized polythiophene and poly(3-hexylthiophene) indicate that the modes induced in the mid-infrared region (ca. 1350-950 cm^{-1}) by their partial oxidation (doping) are highly polarized along the drawn direction. Furthermore, the broad absorption mode occurring in the near-infrared region (around 4000 cm^{-1}) is also found to be polarized along the drawn direction. On the basis of the symmetry analyses of the infrared modes on the polymers, we show that the polymer chains are highly aligned along the drawn direction of the films. This is confirmed by enhancement of electrical conductivity along the drawn direction observed for the uniaxially drawn films of the polymers.

41196 Transport and relaxation of naphthalene in supercritical fluids. Lamb, D.M. (Univ. of Illinois, Urbana (USA)); Adamy, S.T.; Woo, K.W.; Jonas, J. *Journal of Physical Chemistry (USA)*, 93(12): 5002-5005 (15 Jun 1989).

The pressure dependence of diffusion coefficients of naphthalene in supercritical CO_2 and naphthalene-d_8 in supercritical ethylene has been measured by using the NMR fixed field gradient spin-echo Bessel function analysis technique. The pressure dependence of the reorientational motion of naphthalene-d_8 in CO_2 and ethylene has been studied by measuring the deuteron spin-lattice relaxation time, T_1, as a function of pressure at several isotherms. The temperatures were chosen to cover two regions of the naphthalene-supercritical solvent phase diagram. The experimental data allowed the molecular level test of the applicability of the Stokes-Einstein and Debye equations in the binary systems studied. The expression $D(\eta/T)^{0.75}$ = constant represents the experimental diffusion data well, and the modified Debye equation describes the reorientational motion of naphthalene in supercritical CO_2 and ethylene solvents.

41197 Acetylene C-H bond dissociation energy using 193.3-nm photolysis and sub-doppler resolution H-atom spectroscopy: 127 ± 1.5 kcal mol^{-1}. Segall, J. Lavi, R. (Univ. of Southern California, Los Angeles (USA)); Wen, Y.; Wittig, C. *Journal of Physical Chemistry (USA)*, 93(21): 7287-7289 (19 Oct 1989).

H atoms are produced by 193.3-nm C_2H_2 photolysis and probed spectroscopically with sub-Doppler resolution at Lyman-α by using two-photon, two-frequency ionization, for both expansion-cooled and effusive samples. The maximum Doppler shifts are in agreement with $D_0(C_2H\text{-}H)$ = 127 ± 1.5 kcal mol^{-1}, assuming (i) that the fastest H atoms are produced concomitantly with unexcited C_2H and (ii) that vibrationally excited C_2H_2 parent is not the source of these fast H atoms. In the sense that higher detection sensitivity might allow observation of faster H atoms, 127 ± 1.5 kcal mol^{-1} is an upper limit.

41198 FT-IR spectra of CO_2 clusters. Fleyfel, F. (Oklahoma State Univ., Stillwater (USA)); Devlin, J.P. *Journal of Physical Chemistry (USA)*, 93(21): 7292-7294 (19 Oct 1989).

The FT-IR spectra of clusters of CO_2, CO_2 with H_2O, and H_2O with a trace of CO_2 are reported primarily as evidence of the usefulness of a simple small single-pass infrared cold cell in the study of the structural and chemical properties of clusters/microparticles. The CO_2 spectra are confirmatory of and expand on the existing cluster infrared data. For example, the isotopically decoupled $^{13}CO_2$ ν_2 and ν_3 modes are shown to produce singlet bands that are insensitive to cluster size, confirming the view that the size-sensitive structure of the absorption bands of the $^{12}CO_2$ modes is a result of intermolecular coupling through the transition dipoles. New evidence is also presented that supports the view that CO_2 clusters containing a few hundred molecules or more have a crystalline structure at 90 K.

41199 Heterogeneous adsorption equilibria with comparable molecule and pore sizes. Talu, O. (Cleveland State Univ., OH (USA)); Guo, Chang-Jie; Hayhurst, D.T. *Journal of Physical Chemistry (USA)*, 93(21): 7294-7298 (19 Oct 1989).

Isotherms have been measured at temperatures ranging from 0 to 150°C for the adsorption of benzene, toluene, and p-xylene on silicalite. Results show that the shape of the isotherms changes from type I to type IV with decreasing temperature. This unusual behavior is consistent with a two-patch heterogeneous model with surface-phase transition. Although silicalite pore walls are homogeneous, structural heterogeneity results because the adsorbate molecules are comparable in size to channels in silicalite, thereby restricting the motion of the molecules in the surface phase. Isotherms have been modeled by considering that adsorption takes place on a high-energy patch and a low-energy patch. Local equilibria on both patches are described by the Hill-deBoer model. The heat of adsorption is found to go through a maximum as predicted by this model. The two-patch model is effective in correlating the adsorption isotherm for the three test gases. The simulations and data are also in agreement with results obtained by other researchers utilizing different experimental techniques.

41200 Energy barrier by cyclopropylchlorocarbene rearrangement measured by direct observation of the carbene in laser flash spectroscopy. Liu, M.T.H. (Universite de Bordeaux, Talence (France)); Bonneau, R. *Journal of Physical Chemistry (USA)*, 93(21): 7298-7300 (19 Oct 1989).

A transient absorption in the 250-265-nm range is assigned to cyclopropylchlorocarbene generated from the laser flash photolysis of 3-chloro-3-cyclopropyldiazirine. Confidence in this assignment was obtained from the following: (a) the decay of this absorption matches the growth of the pyridinium ylide: (b) the values for the rate constant for reaction of the carbene with 1-hexane obtained by monitoring the carbene at 250 nm and the ylide at 370 nm are similar. The kinetic parameters for the rearrangement of cyclopropylchlorocarbene to 1-chlorocyclobutene are log A = 11.1 and E_a = 7.4 kcal/mol.

41201 High-T_c superconductors and weighted harmonic mean electronegativities. Ichikawa, Shinichi (Univ. of California, Santa Barbara (USA)). *Journal of Physical Chemistry (USA)*, 93(21): 7302-7304 (19 Oct 1989).

A new electronegativity scale based on Mulliken's concept is suggested which indicates systematic changes in the superconductive critical temperature (T_c) with composition for some high-T_c oxides. By this scale the optimum electronegativity seems to exist between 4.7 and 4.9 eV, which is a very narrow range compared to that for low-T_c binary alloys of normal stoichiometry as well as A15 type crystal structure.

41202 A new electronegativity scale. 8. Correlation of the ionization potentials of the main-group atoms (I-VII). Luo, Yu-Ran (Univ. of Southern California, Los Angeles (USA)); Benson, S.W. *Journal of Physical Chemistry (USA)*, 93(21): 7333-7335 (19 Oct 1989).

Linear correlations are found to exist between the ionization potentials of the seven main-group elements (I-VII) and four different measures of their electronegativity. The electronegativity scales tested are the Pauling scale, χ_P, a modification χ_P^2, the Allred-Rochow scale, χ_A, and our recently proposed scale V_X. The latter gives a fit for all main-group elements with an average deviation of 0.14 eV and a root-mean-square deviation of 0.16 eV. The other three scales give fits that show larger deviations by factors of about 2. The maximum deviation with V_X are 0.45 and 0.35 eV for Bi and Pb, respectively. These along with Tl may show anomalies relative to the lighter elements. By use of correlations, estimates are made of the covalent radii of Ra and Po and the IP of Fr and At.

41203 Stabilities of substituted benzyl radicals: Dissociation rates of amino-, hydroxy-, and cyanoethylbenzenes. Suryan, M.M. (National Institute of Standards and Technology, Gaithersburg, MD (USA)); Stein, S.E. *Journal of Physical Chemistry (USA)*, 93(21): 7362-7365 (19 Oct 1989).

Rates of the thermal unimolecular decomposition of amino-, hydroxy-, and cyanoethylbenzenes have been determined by the very low pressure pyrolysis technique. Assuming equal A factors, these rates, relative to the rate of dissociation of ethylbenzene, yield the following ortho, meta, and para, respectively, substituent effects on benzylic C-C bond strengths (kcal/mol): NH_2, −2.7, −0.3, −1.7; OH, −1.7, −0.7, −1.1; and CN, −0.3, 0.4, −1.5. These effects are generally smaller than those for substituted anisoles and follow different trends. Along with the results of ESR studies of Nicholas and Arnold (Can. J. Chem. 1986, 64, 270), the

present substituent effects indicate that a 1-G change in the benzylic hyperfine coupling constant corresponds to a 1.8 kcal mol^{-1} change in bond strength.

41204 MCSCF study of the rearrangement of nitromethane to methyl nitrite. McKee, M.L. (Auburn Univ., AL (USA)). *Journal of Physical Chemistry (USA),* 93(21): 7365-7369 (19 Oct 1989).

An ab initio study has been made of the unimolecular rearrangement of nitromethane to methyl nitrite. Geometry optimizations employing the 6-31G* basis have been carried out for nitromethane and methyl nitrite with a two-configuration wave function and for the unimolecular transition state with a 20-configuration wave function. Energies were determined by using a multiconfigurational expansion, including all configurations generated by excitation from the two highest occupied orbitals into the two lowest empty orbitals (four electrons in four orbitals). The transition state indicates a weak interaction between a methyl radical and nitro radical. In the transition state, the breaking CN bond and the forming CO bond are 3.617 and 3.700 Å, respectively, and there is a significant difference predicted in the NO bond lengths in the transition state (1.371/1.155 Å). At the highest level of calculation used in this work (truncated multireference CI), the unimolecular barrier is predicted to be 10.0 kcal/mol above the sum of CH_3 and NO_2 radical energies, which is in conflict with experiment since the unimolecular rearrangement is observed to occur.

41205 Determination of the absolute photolysis cross section of sodium superoxide at 230 K: Evidence for the formation of sodium tetroxide in the gas phase. Rajasekhar, B. (Univ. of Miami, FL (USA)); Plane, J.M.C.; Bartolotti, L. *Journal of Physical Chemistry (USA),* 93(21): 7399-7404 (19 Oct 1989).

The absolute cross section for the photodissociation process $NaO_2 + h\nu \rightarrow Na + O_2$ has been measured at 230 K by the technique of pulsed excimer laser photolysis of NaO_2 followed by laser-induced fluorescence of the resulting Na fragment, yielding $\sigma(193\ nm) = (4.0 \pm 2.1) \times 10^{-18}\ cm^2$, $\sigma(248\ nm) = (3.9 \pm 2.2) \times 10^{-18}\ cm^2$, and $\sigma(308\ nm) = (1.7 \pm 1.0) \times 10^{-18}\ cm^2$. These results are interpreted by ab initio calculations on the excited electronic states of NaO_2 and by reference to the matrix-isolated UV absorption spectrum of NaO_2, which indicate that photodissociation occurs via excitation from the ground $^2A_2$ state to three $^2B_1$ states, with absorption maxima at 309, 248, and 163 nm. The lowest excited state correlates with $Na(^2S) + O_2(^3\Sigma_g^-)$, and the upper states correlate with $Na(^2S) + O_2(^1\Delta_g)$. The photodissociation cross section from 150 to 400 nm is derived and employed to calculate a photolysis rate of $J(NaO_2) = (4.8 \pm 2.9) \times 10^{-3}\ s^{-1}$ in the upper atmosphere above 70 km. The atmospheric significance of this rate is discussed. The experimental study also indicates that another sodium oxide is formed, with a significantly larger cross section at $\lambda = 248$ nm. We conclude that this is NaO_4. A discussion of its stability and ab initio calculations of its possible structure are presented.

41206 Fluorescence quenching of pyrene by Cu^{2+} and Co^{2+} in sodium dodecyl sulfate micelles. Konuk, R. (Louisiana State Univ., Baton Rouge (USA)); McGlynn, S.P.; Cornelisse, J. *Journal of Physical Chemistry (USA),* 93(21): 7405-7408 (19 Oct 1989).

The quenching of the fluorescence of pyrene by Cu^{2+} and Co^{2+} in SDS micelles is reported. A gradual change in the intensity ratio III/I of the third and first vibronic bands of pyrene fluorescence is found to be a function of quencher concentrations. These changes are attributed to salt effects. Two different mechanisms are posited for changes of the III/I ratio at high electrolyte concentrations: (i) micelles grow into tightly packed aggregates, decreasing the pyrene-water contact area, and/or (ii) a high concentration of salt in the vicinity of the micellar surface decreases the dielectric constant of water, thereby producing a less-polar microenvironment for pyrene.

41207 NMR studies of the sorption of p-xylene, toluene, and benzene on ZSM5 zeolite. Kustanovich, I. (Weizmann Institute of Science, Rehovot (Israel)); Vieth, H.M.; Luz, Z.; Vega, S. *Journal of Physical Chemistry (USA),* 93(21): 7427-7431 (19 Oct 1989).

Deuterium NMR results of p-xylene-d_6, toluene-d_3, and benzene-d_6 as well as proton MASS of p-xylene-d_6 and -d_4 sorbed in H-ZSM5 are reported. The analysis of the results shows that below room temperature the sorbed p-xylene molecules undergo at most reorientation about their para axis. When samples are heated above room temperature, an increasing fraction of the molecules become mobile and unlike in Na-ZSM5 a significant fraction undergoes rapid three-site jumps between intersecting channel segments. This reflects the much weaker hindering effect that H^+ ions have on the diffusion of the guest molecules compared with the larger sodium ions. Toluene behaves similar to p-xylene, but the appearance of the dynamic species starts at significantly lower temperatures. Sorbed benzene molecules in both Na- and H-ZSM5 undergo fast reorientation about their C_6 axes even at the lowest temperature studied (−120°C). Above −60°C, new species appear in which the benzene C_6 axes undergo fast but restricted local reorientation. No direct evidence for fast three-dimensional diffusion of the guest molecules within the zeolite channels was obtained, but this process cannot be ruled out for the species undergoing fast three-site jumps. Heating a sample of sorbed p-xylene in H-ZSM5 to above 100°C results in a structural change in the zeolite framework and concomitantly a change in the distribution of the guest molecules toward more mobile species. Above room temperature, exchange between the aromatic hydrogens of p-xylene and the hydrogens in the zeolite framework takes place.

41208 Association of hydrophobic polymers in H_2O and D_2O: Fluorescence studies with (hydroxypropyl) cellulose. Winnik, F.M. (Xerox Research Center of Canada, Mississauga, Ontario (Canada)). *Journal of Physical Chemistry (USA),* 93(21): 7452-7457 (19 Oct 1989).

The effects of substituting D_2O for H_2O on the fluorescence properties of the pyrene probe in aqueous solutions of (hydroxypropyl)cellulose (HPC) and of pyrene-labeled (hydroxypropyl)cellulose (HPC/Py) have been investigated as a function of temperature and of added surfactants. The polarity-dependence of the vibrational structure of the pyrene emission indicated (1) small differences in polarity between solutions of HPC in D_2O and H_2O below and above the lower critical solution temperature and (2) the formation of micelle like surfactant aggregates with sodium dodecyl sulfate (SDS) and hexadecyltrimethylammonium chloride (HTAC) at concentrations significantly below the critical micelle concentrations of the surfactants. The extent of pyrene excimer emission from solutions of HPC/Py in D_2O and H_2O was found to depend on temperature and on the amount of added surfactants. The excimer emission increased with increasing solution temperature from 4 to 35°C and then dropped sharply before the cloud point of the polymer. Addition of SDS or HTAC to solutions of HPC/Py resulted in a decrease in excimer intensity, with a corresponding increase in monomer intensity. Significant solvent isotope effects were observed. The extent of excimer emission of HPC/Py solutions was larger in D_2O than in H_2O for solution temperatures between 25 and 40°C. The critical aggregation concentration of HTAC/HPC was lower in D_2O (4.9×10^{-4} M L^{-1}) than in H_2O (6.8×10^{-4} M L^{-1}). The results were interpreted in terms of increased hydrophobic interactions between the pyrene labels of the polymer and between HTAC and the polymer in D_2O compared to H_2O.

41209 Effects of potassium adlayer on the adsorption and desorption of hydrogen on a Pd(100) surface. Solymosi, F. (Univ. of Szeged (Hungary)); Kovacs, I. *Journal of Physical Chemistry (USA),* 93(22): 7537-7539 (2 Nov 1989).

Adsorption of H_2 on a K-dosed Pd(100) surface caused a work function increase of 0.7-1.4 eV. Potassium adatoms inhibit the dissociation of H_2, strongly stabilize the absorbed hydrogen on Pd, and shift the release of dissolved hydrogen in Pd by about 130 K to higher temperature.

41210 Direct observation of electron-cation geminate pair produced by picosecond laser pulse excitation in several nonpolar solvents. Hirata, Yoshinori (Osaka Univ. (Japan)); Mataga, Noboru. *Journal of Physical Chemistry (USA),* 93(22): 7539-7542 (2 Nov 1989).

The authors have directly observed the electron-cation geminate recombination process by measuring the picosecond transient absorption spectra of 2,7-bis(dimethylamino)-4,5,9,10-tetrahydropyrene (BDATP) and 1-aminopyrene in several nonpolar solvents at room temperature. The thermalization length of the electron ejected in n-hexane from BDATP excited biphotonically at 295 nm has been estimated to be about 6 nm. The dependence of

the thermalization length on the excess energy is also observed by changing the excitation wavelength and by comparing the ionization of those different solute molecules.

41211 Pyrolysis jet spectroscopy: Rotationally resolved electronic spectrum of dichlorocarbene. Clouthier, D.J. (Univ. of Kentucky, Lexington (USA)); Karolczak, J. *Journal of Physical Chemistry (USA)*, 93(22): 7542-7544 (2 Nov 1989).

The rotationally resolved, gas-phase vibronic spectrum of dichlorocarbene has been recorded by using the technique of pyrolysis jet spectroscopy. Well-resolved rotational lines of the various isotopomers are observed, corresponding to a rotational temperature of 3-5 K. The transition is shown to be $^1B_1 \leftarrow {}^1A_1$ with a ground-state bond length of 1.71_4 Å and a bond angle of $109_4°$.

41212 Photoinduced charge separation across the solid-liquid interface of porous sol-gel glasses: Catalyzed hydrogen generation from water. Slama-Schwok, A. (Hebrew Univ. of Jerusalem (Israel)); Avnir, D.; Ottolenghi, M. *Journal of Physical Chemistry (USA)*, 93(22): 7544-7547 (2 Nov 1989).

Photoinduced electron transfer between $[Ir(bpy)_2(C^3,N')bpy]^{3+}$, Ir(III), trapped in a porous silica glass generated by the sol-gel process, and 1,4-dimethoxybenzene (DMB) dissolved in a water phase in the pores of the glass, was observed. The kinetics of the redox reactions associated with the Ir(II) + DMB^+ radical ion pair were studied at different pH and ionic strength values. A retardation of 4 orders of magnitude of the back-electron-transfer process, with respect to homogeneous solutions, was observed at neutral pH for ≈ 25% of the generated Ir(II). The effect is attributed to the immobilization of Ir(II) by trapping in the glass matrix and of DMB^+ by adsorption on the pores surface. At acidic pH, retardation of the back-reaction leads to catalyzed hydrogen generation from water.

41213 Low-temperature (144 K) ^{129}Xe NMR of amorphous materials: Effects of pore size distribution on chemical shift. Cheung, T.T.P. (Phillips Petroleum Co., Bartlesville, OK (USA)). *Journal of Physical Chemistry (USA)*, 93(22): 7549-7552 (2 Nov 1989).

^{129}Xe nuclear magnetic resonance (NMR) spectra of xenon adsorbed on amorphous silica, alumina, and silica-alumina have been measured as a function of the xenon loading at 144 K. At low xenon loadings, the ^{129}Xe chemical shift shows a nonlinear dependence on the xenon loading. In the amorphous alumina and silica-alumina, a parabolic-like curvature in the chemical shift similar to that observed in Y zeolites with (+2) cations is observed even though the exon adsorption sites in the amorphous materials are much weaker. The nonlinear dependence of the ^{129}Xe chemical shift on the xenon loading can be explained by the presence of a broad distribution in the micropore size and the fact that the chemical shift is an inverse function of the micropore size.

41214 Vinylidene radical cation: A sizable barrier to unimolecular rearrangement to the acetylene radical cation. Hamilton, T.P. (Univ. of Georgia, Athens (USA)); Schaefer, H.F. III. *Journal of Physical Chemistry (USA)*, 93(22): 7560-7562 (2 Nov 1989).

The activation energy for isomerization of the lowest electronic state ($^2B_1$) of the radical cation of vinylidene to the $^2\Pi_u$ acetylene radical cation is predicted to be about 10 kcal/mol by high-level ab initio theory. Thus, the $^2B_1$ cation is metastable and may be observable. This is in conflict with conclusions based on previous theoretical results but apparently in agreement with two recent experimental studies employing collisional activation mass spectrometry.

41215 Stability of lyotropic phases with curved interfaces. Gruner, S.M. (Princeton Univ., NJ (USA)). *Journal of Physical Chemistry (USA)*, 93(22): 7562-7570 (2 Nov 1989).

The diverse structural forms of lipid-water phases are representative of those found in many lyotropic and amphiphilic systems. These structures consist of interfaces which divide the material into hydrophobic and hydrophilic volumes. The net result of a very complex set of intermolecular interactions is that the interfaces behave as surfaces endowed with a spontaneous curvature and whose separations are subject to constraints of molecular lengths and component densities. Phase transitions which result in an abrupt change of the curvature of the interfaces may be understood phenomenologically as a competition between the elastic energy of bending the interfaces and energies resulting from the constraints of interfacial separation. The application of this approach is reviewed for transitions between lamellar, hexagonally packed cylindrical, close-packed spherical, and bicontinuous cubic structures of diacyl biomembrane lipids. It is shown that the structural dimensions and phase transitions of the lipid mesomorphs may be largely understood in terms of the phenomenological model. The existence of a spontaneous curvature associated with the lipid monolayers of bilayers implies that biomembranes exist in a state of compositionally controlled elastic stress which may provide a chemically nonspecific rationale for the types of lipids found in cell membranes. A discussion is given of the evidence that membrane proteins are functionally sensitive to the elastic stress. The article concludes with a summary of related outstanding problems.

41216 Excitation energy flow in chlorosome antennas of green photosynthetic bacteria. Mimuro, Mamoru (National Institute for Basic Biology, Aichi (Japan)); Nozawa, Tsunenori; Tamai, Naoto; Yamazaki, Iwao; Shimada, Keizou; Lin, Su; Knox, R.S.; Wittmershaus, B.P.; Brune, D.C.; Blankenship, R.E. *Journal of Physical Chemistry (USA)*, 93(21): 7503-7509 (19 Oct 1989).

Energy flow in whole cells of the thermophilic green photosynthetic bacterium Chloroflexus aurantiacus was studied by measurements of time-resolved fluorescence spectra in the picosecond time range, detected by both streak camera and single-photon counting methods. These data characterize the energy-transfer sequence from bacteriochlorophyll c (BChl c), found in membrane-associated antenna structures called chlorosomes, to BChl a in the chlorosome baseplate, then to a BChl a antenna complex in the cytoplasmic membrane, and finally to the photochemical reaction center. Upon selective excitation of BChl c in chlorosomes, the decay time of the emission arising from BChl c was 16 ps. The apparent rise time of the emission from the baseplate pigment was < 3 ps. The time course of the transfer from the baseplate BChl a to the membrane-bound BChl a complex was clearly detected. A major 41-ps decay component of the baseplate BChl a emission corresponded to the rise term found for the membrane-bound BChl a emission. With a kinetic analysis, a model is proposed for the structure and function of the chlorosome antenna system in Chloroflexus aurantiacus. The data suggest that the excitation-transfer process may utilize a novel mechanism that takes advantage of the photophysical properties of aggregated pigments. BChl c molecules form naturally occurring aggregates with oligomeric structures similar to J aggregates, but very different from the organization of antenna pigment-proteins from other photosynthetic organisms. These oligomers absorb light and transfer excitations to a small amount of BChl a antenna proteins in the baseplate. The baseplate acts as an energy-transfer interface between the chlorosome and the antenna protein complexes located within the membrane. The integral membrane antenna complexes in turn deliver the excitations to the reaction center where photosynthesis is initiated by electron-transfer reactions.

41217 Conformational disorder in crystalline n-alkanes prior to melting. Kim, Y. (Univ. of California, Berkeley (USA)); Strauss, H.L.; Snyder, R.G. *Journal of Physical Chemistry (USA)*, 93(21): 7520-7526 (19 Oct 1989).

By means of infrared spectroscopy, the concentration of gauche bonds has been monitored as a function of increasing temperature for the crystalline n-alkanes, C_n, n = 17, 25, 36, 50, and 60. For each n-alkane, the number of gauche bonds, and hence the degree of conformational disorder, is found to increase as the melting point is approached. The temperature at which the increase in disorder becomes measurable is 10-40 K below the melting point. For C_{17}, C_{25}, and C_{36}, the increase begins abruptly and occurs in association with a solid-solid phase transition. However, for the C_{50} and C_{60}, the onset of disorder is not associated with a solid-solid transition and occurs gradually. Therefore, C_{50} and C_{60} can be said to undergo true premelting. Although the onset of disordering for the shorter chains (C_{17}, C_{25}, C_{36}) occurs abruptly and that for the longer chains (C_{50}, C_{60}) gradually, there are, otherwise, close similarities. The similarities are in the width of the temperature range over which disordering occurs, in the total concentration of

the disorder, and in its distribution. These similarities suggest a common disordering mechanism. Our earlier studies on conformational disorder for crystalline n-alkanes in the hexagonal phase suggest that the disordering mechanism involves longitudinal diffusion. In addition to premelting disorder, we have observed an inherent or background disorder for melt crystallized samples. The concentration of this disorder is temperature independent up to the temperature of premelting and, on a gauche bond per chain basis, has essentially the same value for all the n-alkanes studied here. The origin of this disorder is not clear, but it is probably associated with the lamellar surface.

41218 Effects of temperature and clustering on mobility of ions in CO_2. Berant, Z. (Nuclear Research Center, Beer-Sheva (Israel)); Karpas, Z.; Shahal, O. *Journal of Physical Chemistry (USA)*, 93(21): 7529-7532 (19 Oct 1989).

The effects of temperature and clustering on the mobility of ions drifting in CO_2 at ambient pressure were studied by ion mobility spectrometry (IMS). A semiempirical procedure for obtaining quantitative data on the size of the cluster was applied. At 90°C, about three CO_2 molecules, on average, clustered around protonated amine core ions. As the temperature was raised, the number of clustered molecules decreased, and above 200°C, it was practically zero. A clear mass-mobility correlation was observed in the protonated aliphatic amines even at 90°C. Protonated pyridine, picoline, lutidine, and collidine were unresolved at this temperature, but as the temperature was raised, resolution improved. On the whole, use of CO_2 as a drift gas in IMS, although inferior in some cases, should not be precluded.

41219 Temperature dependence of fluorescence lifetime distributions in 1,3-di(1-pyrenyl)propane with the maximum entropy method. Siemiarczuk, A. (Univ. of Western Ontario, London (Canada)); Ware, W.R. *Journal of Physical Chemistry (USA)*, 93(22): 7609-7618 (2 Nov 1989).

The fluorescence decay of the monomer emission band of 1,3-di(1-pyrenyl)propane has been investigated at different temperatures in order to test models implying either the presence of three distinct species (one monomer and two excimers) or a more complex situation, giving rise to lifetime distributions. The decay curves were analyzed by free-floating discrete multiexponential functions (up to four exponentials) and as well s with the maximum entropy method. The latter uses a set of up to 200 exponential terms with fixed lifetimes and is capable of recovering distribution over a broad lifetime range. The result clearly indicate the presence of a distribution of conformers in the monomer state, which leads to a broad monomer lifetime distribution, the relative width of which is temperature dependent. This distribution of conformers also accounts for the inability to fit the high-precision monomer decays collected to high count level at higher temperatures with a three-exponential function.

41220 Deuterium nuclear magnetic resonance measurements of rotation and libration of benzene in a solid-state cyclamer. Hoa, J. (Univ. of California, San Diego (USA)); Vold, R.R.; Vold, R.L.; Etter, M.C. *Journal of Physical Chemistry (USA)*, 93(22): 7618-7624 (2 Nov 1989).

Deuterium NMR spectroscopy has been used to study the molecular motion of benzene-d_6 in a 1,3-cyclohexanedione cyclamer with a host:guest ratio of 6:1 and, for comparison, in pure solid benzene-d_6. The quadrupole coupling parameters for pure benzene-d_6 at 87 K were found to be $e^2qQ/h = 183 \pm 1$ kHz and $\eta = 0.04 \pm 0.005$, in accord with literature values. e^2qQ/h for pure benzene-d_6 is slightly temperature dependent, dropping to 177 ± 1 kHz at 252 K. Values of e^2qQ/h for benzene-d_6 trapped in the cyclamer were found to be the same, within $\pm$ 1 kHz experimental error, as those of pure solid benzene-d_6 at the same temperature. Quadrupole echo line shapes were recorded at 40- and 100-μs pulse spacings and at several temperature between 87 and 252 K for benzene-d_6, and between 124 and 290 K for the cyclamer. Major features of the line shapes can be accounted for in terms of large angle jumps about the major symmetry axis. The activation energy of jump motion is 16.5 ± 0.1 kJ/mol for benzene-d_6 and 24.9 ± 0.4 kJ/mol for benzene-d_6 in the cyclamer. Anisotropic displacement parameters derived from room-temperature X-ray data, as well as the observed temperature dependence of the quadrupole coupling constant both for benzene-d_6 in the cyclamer and for pure benzene-d_6, can be ascribed to fast vibrational motion. A simple model that describes this motion in terms of restricted wobbling of the ring normal can be used to fit both the NMR and X-ray data.

41221 C 1s excitation of azulene and polyazulene studied by electron-energy-loss spectroscopy and x-ray absorption spectroscopy. Hitchcock, A.P. (McMaster Univ., Hamilton, Ontario (Canada)); Tourillon, G.; Garrett, R.; Lazarz, N. *Journal of Physical Chemistry (USA)*, 93(22): 7624-7628 (2 Nov 1989).

The oscillator strength for C 1s excitation of azulene in the gas phase has been derived from electron energy loss spectra recorded under dipole-dominated scattering conditions. The spectral features are assigned to C 1s excitations to π^* and σ^* valence unoccupied orbitals. The azulene C 1s spectrum is compared to that of naphthalene and the differences are related primarily to changes in the π^* orbital energies. The near-edge X-ray absorption fine structure (NEXAPS) spectra of thin films of polyazulene electrochemically deposited on Pt are also reported. The orientation dependence of the C 1s spectrum of very thin films assists spectral interpretation. Changes in the C 1s NEXAFS spectrum associated with electrochemical doping to form a conducting state of the polymer are discussed in terms of the probable conduction mechanism in doped polyazulene.

41222 Interaction of CO_2 and water investigated by a combination of ab initio and SOLDRI-MM2 techniques. Damewood, J.R. Jr. (Univ. of Delaware, Newark (USA)); Kumpf, R.A.; Muehlbauer, W.C.F. *Journal of Physical Chemistry (USA)*, 93(22): 7640-7644 (2 Nov 1989).

The interaction of CO_2 and water is investigated by a combination of ab initio and SOLDRI-MM2 techniques. Ab initio results at levels of theory as high as MP2/6-311+G**//6-31G** are found to be in reasonable agreement with experiment. The R.θ potential energy surfaces generated for CO_2, H_2O by SOLDRI-MM2 and ab initio methods at the 6-31G** level are found to be in very good agreement with a root mean square deviation in the binding region of only 0.8 kcal/mol.

41223 Solvent effects in the reactions of peroxyl radicals with organic reductants. Evidence for proton-transfer-mediated electron transfer. Neta, P. (National Institute of Standards and Technology, Gaithersburg, MD (USA)); Huie, R.E.; Maruthamuthu, P.; Steenken, S. *Journal of Physical Chemistry (USA)*, 93(22): 7654-7659 (2 Nov 1989).

Absolute rate constants for the reactions of substituted methylperoxyl radicals with ascorbate, urate, trolox (6-hydroxy-2,5,7,8-tetramethylchroman-2-carboxylic acid), and TMPD (N,N,N',N'-tetramethyl-p-phenylenediamine) have been determined by pulse radiolysis is different solvents. In water-alcohol or water-dioxane solutions, the rate constants for trihalomethylperoxyl radicals generally increase with increasing water content. The rate constant for reaction of $CCl_3O_2\cdot$ radicals with trolox was measured in water, MeOH, i-PrOH, t-BuOH, ethylene glycol, diethyl ether, dioxane, acetone, acetonitrile, formamide, dimethylformamide, pyridine, and CCl_4. The rate constants were found to correlate well with a two-parameter equation that includes the dielectric constant of the solvent and the coordinate covalency parameter, a measure of the proton-transfer basicity of the solvent. Kinetic isotope effects in H_2O/D_2O of about 2 and activation entropies of about -1o eu for reduction of $RO_2\cdot$ by the organic reductants indicate that electron transfer to the peroxyl radical is concerted with the transfer of proton from the solvent to the incipient hydroperoxide anion.

41224 Collision-induced electronic quenching of BH($A^1\Pi$). Douglass, C.H. (Naval Research Lab., Washington, DC (USA)); Rice, J.K. *Journal of Physical Chemistry (USA)*, 93(22): 7659-7664 (2 Nov 1989).

Electronic quenching cross sections of BH($A^1\Pi$) in $\nu' = 0$ were measured by examining fluorescence decay times in the presence of 16 collision partners at 298 K. The partners exhibit wide variations in mass, electric dipole moment, and higher order moments. Except for the extremely low cross sections measured for He and SF_6, values range from 5 to 150 Å^2. Of the 14 remaining partners, 11 are represented moderately well by a multipole attractive force

model, OCS and CH_2F_2 fall well below the calculated cross section, and $CHFCl_2$ has an experimental cross section larger than predicted by this model. A temperature comparison is made for the quenching of $BH(A^1\Pi)$ by CO_2 at 298 and 473 K. The measured rate constant at 473 K exhibits a 10% decrease compared to the 298 K value with an uncertainty of ≈ 11%.

41225 Spin-orbit relaxation rates of Bi($6p^3$,$^2D_{3/2}$) following photolysis of $Bi(CH_3)_3$ at λ = 193 nm. Holloway, J.S. (The Aerospace Corp., Los Angeles, CA (USA)); Koffend, J.B.; Heidner, R.F. III. *Journal of Physical Chemistry (USA)*, 93(22): 7665-7669 (2 Nov 1989).

Rate coefficients for the collisional relaxation of the first excited spin-orbit state of Bi ($6p^3$, $^2D_{3/2}$) have been measured at 295 K for Ar, CO_2, SF_6, H_2, D_2, HF, and DF. The excited Bi atoms were prepared by excimer laser photolysis of trimethylbismuth (TMB) at 193 nm and monitored directly in emission. The rate coefficient for quenching by the precursor TMB and a lower limit for removal by CH_3 photofragments have also been established. Where applicable, our results are compared with the earlier work of Bevan and Husain and of Trainor. The suitability of long-range interaction models is discussed for those cases where isotopic substitution leads to markedly different quenching rates.

41226 Stereocontrol of the red light induced photoepoxidation of 2-butenes by nitrogen dioxide in solid Ar. Nakata, M. (Lawrence Berkeley Lab., CA (USA)); Frei, H. *Journal of Physical Chemistry (USA)*, 93(22): 7670-7677 (2 Nov 1989).

Photooxidation of cis-2-butene was initiated in an inert gas matrix by exciting cis-2-butene-NO_2 pairs at red, yellow, and green wavelengths (NO_2 $^2B_2 \rightarrow X^2A_1$). Chemical reaction was monitored by FT-IR spectroscopy, and emission from an Ar ion or a tuned CW dye laser was used for photolysis. As in the case of the trans-2-butene + NO_2 reaction reported earlier, 2,3-epoxybutane was the only final oxidation product observed upon direct photolysis of reactant pairs. While in the case of the trans-2-butene reaction stereochemical retention was complete, we found in the cis case 85% of the epoxide with retained configuration when conducting the reaction at low matrix concentration. This fraction decreased with increasing reactant to matrix ratio. Infrared bands of two conformers of a butyl nitrite radical were observed concurrently with the epoxide, one syn, the other anti with respect to conformation (CH_3 groups) about the central CC bond. A correlation was found between the syn to anti nitrite radical and the cis to trans epoxide ratios, suggesting a common transient precursor. It is most probably an oxirane biradical, whose conformation determines the stereochemistry of the epoxide product. The photolysis wavelength dependence of the product growth kinetics was studied, and relative reaction of efficiencies so obtained are shown to give insight into aspects of the dynamics of the reaction that relate to the observed product and stereospecificity.

41227 Surface photochemistry: 6. CH_3Br on Pt(111). Liu, Z.M. (Univ. of Texas, Austin (USA)); Costello, S.A.; Roop, B.; Coon, S.R.; Akhter, S.; White, J.M. *Journal of Physical Chemistry (USA)*, 93(22): 7681-7688 (2 Nov 1989).

The surface photochemistry of monolayer and submonolayer CH_3Br on Pt(111) has been studied by temperature-programmed desorption (TPD) and X-ray photoelectron spectroscopy (XPS) to diagnose the results of continuous low-intensity ultraviolet irradiation. For wavelengths of 300 nm or less, and surface temperatures near 100 K, evidence is presented for the nonthermal cleavage of the C-Br bond and the formation of adsorbed Br atoms and CH_3 groups. The wavelength dependent is strong and red-shifted compared to the gas-phase electronic excitation spectrum of CH_3Br. By quantitative XPS, the maximum photolysis yield of retained Br from one monolayer of CH_3Br is 60 ± 5%. While there is some slow thermal desorption, there is no detectable photodesorption of the parent during irradiation. Excitation mechanisms and product formation channels are discussed.

41228 Theoretical prediction of the vibrational spectrum, geometry, and scaled quantum mechanical force field for phenylacetylene. Csaszar, A.G. (Eoetvoes Lorand Univ., Budapest (Hungary)); Fogarasi, G.; Boggs, J.E. *Journal of Physical Chemistry (USA)*, 93(22): 7644-7651 (2 Nov 1989).

The optimized geometry and the complete harmonic force field of phenylacetylene have been determined by ab initio Hartree-Fock calculations, using a 4-21 Gaussian basis set. Systematic errors in the bond lengths, characteristic at this level of theory, were corrected by empirical offset values. Only at the ipso position does the equilibrium geometry obtained in this way differ significantly from the experimental one (MW; r_g). A detailed analysis suggests that while the experimental ipso CCC angle may be correct, the ipso CC distance should be reconsidered. The force field was evaluated at the above geometry as a reference. To remove systematic deficiencies, the final scaled quantum mechanical (SQM) force field was obtained by applying scale factors optimized previously for benzene and acetylene. All force constants that occur both in phenylacetylene and in the isoelectronic molecule benzonitrile are very nearly the same. Frequencies calculated from the SQM force field of phenylacetylene confirm, with only a few exceptions, the published experimental assignments for all four isotopomers investigated. When the C-H (and C-D) stretching frequencies, perturbed by anharmonicity, are not considered, the average deviation between the observed and calculated frequencies is below 10 cm^{-1}. Theoretical dipole moment derivatives are discussed, and infrared intensities are presented. Quartic centrifugal distortion constants, calculated also from the SQM force field, agree well with the results of an incomplete experimental study.

41229 Reactions of hydrogen halides with clusters of ammonia molecules. Breen, J.J. (Pennsylvania State Univ., University Park (USA)); Kilgore, K.; Wei, S.; Tzeng, W.B.; Keesee, R.G.; Castleman, A.W. Jr. *Journal of Physical Chemistry (USA)*, 93(22): 7703-7707 (2 Nov 1989).

Reactions between an ammonia cluster beam and an effusive source of hydrogen halide molecules are shown to form mixed clusters containing as many as four hydrogen halide molecules. Multiphoton ionization of the product clusters using the third harmonic of a Q-switched Nd:YAG laser leads mainly to species of the comparison $H^+(NH_3)_n(NH)_m$, where X = Cl or I and n is greater than m. In addition, for the case where X = I the species $NH_3 \cdot HX^+$ and $H^+(NH_4)(HX)$ are positively observed. Evidently they arise due to the fragmentation of clusters containing more than one HI molecule; $H^+(NH_3)_2HI$ is the smallest mixed cluster observed to be formed under single collision conditions. These results, along with information contained in the mixed cluster distributions, suggest a replacement reaction mechanism for the formation of the mixed clusters. Evidence is obtained which suggests that a solvated ion pair arises in HI-ammonia clusters containing about 10 NH_3 molecules.

41230 Solvent effects on intervalence electron-transfer energies for biferrocene cations: Comparisons with molecular models of solvent reorganization. McManis, G.E. (Purdue Univ., West Lafayette, IN (USA)); Gochev, A.; Nielson, R.M.; Weaver, M.J. *Journal of Physical Chemistry (USA)*, 93(22): 7733-7739 (2 Nov 1989).

Outer-shell electron-transfer reorganization energies, λ_0, as evaluated from intervalence band maxima, E_{op}, for bis(ferrocenyl)acetylene (BFA^+), 1,4-bis(ferrocenyl)butadiyne (BFB^+), and biferrocene (BF^+) cations in 13 solvents are compared with the predictions of some contemporary models of solvent reorganization in order to ascertain the importance of noncontiuum, or solvent molecularity, factors to λ_0. Measurements of E_{op} were made in relatively polar media in solutions containing low concentrations (less than a few millimoles per liter) of PF_6^- so to minimize complications from ion pairing. While E_{op} correlates roughly with $\epsilon_{op}^{-1} - \epsilon_s^{-1}$ (ϵ_{op} and ϵ_s are optical and static dielectric constants), the plots display considerable scatter; smaller slopes and larger intercepts are obtained than anticipated from such dielectric continuum treatments so that E_{op} tends to be smaller than the two-sphere continuum estimates, E_{op}(con). However, the relative E_{op} values for all three biferrocenes are essentially independent of the solvent; E_{op} for BFB^+ relative to BFA^+ is in good agreement with the predictions of the two-sphere model (but not ellipsoid models), although the E_{op} values for BF^+ are larger than expected, most probably due to electron delocalization effects. Taking into account anticipated electronic state modulation effects (ref 38) on the potential energy well improves somewhat the

overall match with the observed E^{op} values but cannot account for the scatter in the E_{op} - (ϵ^{op-1} - ϵ_s^{-1}) plots. Comparisons are made with the recent mean spherical approximation (MSA) treatment of solvent reorganization (ref 10).

41231 Second hyperpolarizabilities and static and optical-frequency polarizability anisotropies of benzene, 1,3,5-trifluorobenzene, and hexafluorobenzene. Gentle, I.R. (Univ. of Sydney, New South Wales (Australia)); Ritchie, G.L.D. *Journal of Physical Chemistry (USA)*, 93(22): 7740-7744 (2 Nov 1989).

Measurements of the electrooptical Kerr effects at 632.8 nm of gaseous benzene, 1,3,5-trifluorobenzene, and hexafluorobenzene over a range of temperature (≈ 315-490 K) and pressure (≈ 10-90 kPa) are reported. Analyses of the temperature dependences show that for all three molecules the temperature-independent contribution to the effect, which arises from distortion of the electronic structure by the electric field, is negligibly small in comparison with the temperature-dependent contribution from molecular orientation. Reliable values of the static polarizability anisotropies are also obtained, and these are compared with optical-frequency polarizability anisotropies derived from Rayleigh depolarization ratios. Because of the oppositely signed vibrational contributions in benzene and hexafluorobenzene, the ratio of the static to the optical-frequency anisotropy is less than unity for benzene but greater than unity for hexafluorobenzene. Such an outcome effectively vitiates the common assumption that the ratio of the anisotropies can be approximated by the ratio of the mean static and optical-frequency polarizabilities.

4004 Electrochemistry

Refer also to citation(s) 40842, 40846, 40853, 40906, 40993, 41131, 41188, 41195

41232 (N-90-20454, pp. 51-60) **The electrochemical generation of useful chemical species from lunar materials.** Tsai, K.J.; Kuchynka, D.J.; Sammells, A.F. Eltron Research, Inc., Aurora, IL (USA). Dec 1989. (NASA-CP-3056;E-4708;NAS-1.55:3056;CONF-8904196-: 2. space electrochemical research and technology conference, Cleveland, OH (USA), 11-13 Apr 1989). In *Space electrochemical research and technology (SERT), 1989.* Available from NTIS, PC A16/MF A02.

Electrochemical cells have been fabricated for the simultaneous generation of oxygen and lithium from a Li_2O containing molten salt (Li_2O-LiCl-LiF). The cell utilizes an oxygen vacancy conducting solid electrolyte, yttria-stabilized zirconia (YSZ), to effect separation between oxygen evolving and lithium reduction half-cell reactions. The cell, which operates at 700 to 850 C, possesses rapid electrode kinetics at the lithium-alloy electrode with exchange current density (i_o) values being greater than 60mA sq cm. When used in the electrolytic mode, lithium produced at the negative electrode would be contiguously removed from the cell for later use (under lunar conditions) as an easily storable reducing agent (compared to H2) for the chemical refining of lunar ores. Because of the high reversibility of this electrochemical system, it has also formed tha basis for the lithium oxygen secondary battery system which possesses the highest theoretical energy density yet investigated.

41233 Simultaneous ellipsometric and microgravimetric measurements during the electrochemical growth of polyaniline. Rishpon, J. (Los Alamos National Lab., NM (USA)); Redondo, A.; Gottesfeld, S. pp. 68 of American Chemical Society, Division of Colloid and Surface Chemistry. American Chemical Society, Washington, DC (US) (1990). (CONF-900402-: 199. national meeting of the American Chemical Society, Boston, MA (USA), 22-27 Apr 1990).

The authors describe an experimental system for simultaneous quartz crystal microbalance (QCMB) and ellipsometric measurements performed in situ during the growth of a thin film on an electrode surface. The film studied is grown on a Pt electrode sputtered onto a quartz crystal which serves as the microbalance. They describe here results of such combined measurements performed during the anodic growth of polyaniline in aqueous acid solutions showing substantial variations in film density as a function of electrochemical growth conditions.

41234 Electrochemical oxidation of methanol on Pt and Sn-modified Pt surfaces. Norton-Haner, A. (Lawrence Berkeley Lab., CA (USA)); Ross, P.N. pp. 94 of American Chemical Society, Division of Colloid and Surface Chemistry. American Chemical Society, Washington, DC (US) (1990). (CONF-900402-: 199. national meeting of the American Chemical Society, Boston, MA (USA), 22-27 Apr 1990).

Two different modifications of Pt surfaces by Sn were examined. In one study, a single crystal of intermetallic compound Pt_3Sn was synthesized and the activity of the clean UHV-characterized low index surfaces for methanol oxidation was determined. In a second study, the three low index surfaces of pure Pt crystals were modified by adsorption of Sn ions from sulfuric acid solution, and the kinetics of methanol oxidation measured in Sn-free electrolyte.

4005 Photochemistry

Refer also to citation(s) 41131, 41496, 41807

41235 (HMI-B-470) **HMI scientific report - chemistry 1988.** Hahn-Meitner-Institut Berlin GmbH (Germany, F.R.). 1989. 40p. (In German). Order Number DE90510214. Available from NTIS (US Sales Only), PC A03/MF A01.

Results of the R and D activities are reported, dealing with the following subjects: Interface processes and energy conversion, high-energy photochemistry and radiation chemistry as well as trace elements chemistry. A list of publications and lectures is added and gives a view on results obtained in research and development. (EF).

41236 (HMI-B-471) **HMI scientific report - chemistry 1987.** Hahn-Meitner-Institut Berlin GmbH (Germany, F.R.). 1989. 40p. (In German). Order Number DE90510213. Available from NTIS (US Sales Only), PC A03/MF A01.

Results of the R and D activities of the Radiation Chemistry Department, Hahn-Meitner-Institut, are reported, primarily dealing with the following subjects: Interface processes and energy conversion, high-energy photochemistry and radiation chemistry as well as trace elements chemistry. A list of publications and lectures is added and gives a view on results obtained in research and development. (EF).

41237 (LBL-29112) **Nitrogen dioxide fluorescence following photolysis in a supersonic jet.** Sisk, W.N. Lawrence Berkeley Lab., CA (USA). May 1990. 261p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00098. Order Number DE90014164. Available from NTIS, PC A12/MF A01 - OSTI; GPO Dep.

A supersonic jet of N_2O_4 has been photolyzed at three wavelengths: 193, 248 and 351 nm. The resultant fluorescence of NO_2 was dispersed, and from this the energy distribution of fluorescent NO_2 has been determined by the Photolysis Induced Fluorescence (PIF) scheme. The spread of the energy distribution increased with decreasing photolysis wavelength. The photolysis of NO_2Cl at 248 nm resulting in NO_2 fluorescence was analyzed by the PIF (Photolysis Induced Fluorescence) deconvolution scheme and these results were compared to and Time-of-Flight/Mass Spectrometry (TOF/MS) performed previously in Y.T. Lee's lab by Oh and Coworkers. The results from the pulsed beam PIF agreed with the TOF/MS results leading to 5 product channels in NO_2Cl photolysis. The undispersed fluorescence of NO_2 is observed following the excitation of NO_2Cl, N_2O_4, and NO_2. The Photolysis Induced Fluorescence Excitation (PIFEX) spectrum of NO_2Cl shows a decrease in the fluorescence quantum yield, ϕ_f, when scanning to shorter wavelength. This decrease in ϕ_f is attributed to the onset of the NO + O + Cl channel. The NO_2 LIF spectra yield information on 3 parallel bands observed near 400 nm as well as a confirmation on D_0, which is found here to be 3978.3 ± 0.03 Å (air-calibrated).

41238 Near-threshold photoionization of nickel clusters: ionization potentials for Ni_3 to Ni_{90}. Knickelbein, M.B. (Chemistry Division, Argonne National Laboratory, Argonne, Illinois 60439

(USA)); Yang, S.; Riley, S.J. *Journal of Chemical Physics (USA)*, 93(1): 94-104 (1 Jul 1990). DOE Contract W-31109-ENG-38.

The threshold photoionization efficiency (PIE) curves for nickel clusters in the size range Ni_3 to Ni_{90} have been measured by laser photoionization with detection by time-of-flight mass spectrometry. Both warm (≤298 K) and cold (≤77 K) clusters have been studied. The PIE curves for 298 K clusters display thermal tails, while these tails are smaller for cold clusters. Cluster ionization potentials (I.P.s) have been determined by two methods: the Watanabe procedure and linear extrapolation of the PIE curves. Dramatic dependence of I.P. on cluster size is found for clusters smaller than 11 atoms, while the I.P.s of larger clusters decrease relatively smoothly and nearly monotonically from 5.84 eV for Ni_{11} to 5.56 eV for Ni_{90}. The I.P.s for clusters larger than Ni_{40} show the linear dependence on reciprocal radius (R^{-1}) predicted by the conducting spherical drop model of small particle I.P.s, but do not fit the model quantitatively unless the limiting ($R^{-1} \rightarrow 0$) work function is reduced by 0.46 eV from the bulk polycrystalline value. The differences between the thermal tails of the room temperature and 77 K PIE curves diminish with increasing cluster size, suggesting a reduced difference between neutral and ionic structures for larger clusters. In general, there is poor agreement between our experimental results and theoretically calculated I.P.s for small nickel clusters, with the exception of the recently reported tight-binding theory results of Pastor *et al.* [Chem. Phys. Lett. **148**, 459 (1988)].

41239 The multiplet state distribution of $O(^3P_J)$ produced in the 193 nm photodissociation of SO_2. Huang, Y. (Department of Chemistry, University of Illinois at Chicago, Box 4348, Chicago, Illinois 60680 (USA)); Gordon, R.J. *Journal of Chemical Physics (USA)*, 93(1): 868-869 (1 Jul 1990).

The multiplet state distribution of oxygen atoms produced in the photodissociation of SO_2 was measured in a pump-and-probe experiment. An ArF laser was used to dissociate the parent molecule, while the $O(^3P)$ product was detected by two-photon laser-induced fluorescence under collisionless conditions. The multiplet populations were found to be 59.2%±5.0%, 29.5%±3.2%, and 11.4%±3.3% for J=2, 1, and 0, respectively. These results are indistinguishable from the statistical distribution of 5:3:1.

41240 Laser flash photolysis studies of dibenzosuberenyl cations and radical cations. Johnston, L.J. (National Research Council of Canada, Ottawa, Ontario (Canada)); Lobaugh, J.; Wintgens, V. *Journal of Physical Chemistry (USA)*, 93(21): 7370-7374 (19 Oct 1989).

A variety of dibenzosuberenyl systems have been investigated by laser flash photolysis. Excitation of the parent alcohol, 5-dibenzosuberenol, in trifluoroethanol yields the corresponding carbocation via heterolysis of the C-OH bond. The carbocation shows a long-lived (> 100 μs) absorption at 525 nm with a second band at 390 nm, is readily quenched by nucleophiles (k_q(azide) = 1.1 × 10^9 M^{-1} s^{-1}), and fluoresces with a lifetime of 35 ns. In other solvents, the transient phenomena are dominated by the formation of the radical cation via a two-photon process. both dibenzosuberene and 5-phenyl-5-dibenzosuberenol also yield radical cations in a variety of polar solvents. The radical cations show absorption spectra with maxima at 470 nm and a broad band in the 700-nm region, have lifetimes in oxygenated solutions of >1.5 μs, and react with a variety of nucleophiles. Their identity has been confirmed on the basis of their independent generation with the electron-transfer sensitizers chloranil and 1,4-dicyanonaphthalene and by reaction with 1,2,4-trimethoxybenzene.

4006 Radiation Chemistry

Refer also to citation(s) 41235, 41236

41241 (BARC–1470) **Programming a microcomputer for online data acquisition and processing in pulse radiolysis experiments. Part 2: Spectrum acquisition and processing.** Panajkar, M.S. (Bhabha Atomic Research Centre, Bombay (India). Chemistry Div.); Moorthy, P.N.; Shirke, N.D. Bhabha Atomic Research Centre, Bombay (India). 1989. 23p. Order Number DE90634384. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

In pulse radiolysis experiments one of the informations sought is the absorption spectrum of the transient species generated in the system. As the transient species decay over a period of time, it is necessary to acquire the spectrum at fixed times after the pulse. The present report describes the necessary methodology for on-line acquisition and processing of such time resolved spectra from transient signals captured in a digital storage scope interfaced to an IBM compatible personal computer. (author). 11 figs.

4007 Radiochemistry and Nuclear Chemistry

Refer also to citation(s) 40392, 40448

41242 (INP–1380/C) **Production of Ga-67 from the zinc target.** Grychowski, P. (Institute of Nuclear Physics, Cracow (Poland)); Mikulski, J.; Ochab, E.; Panasiewicz, J. Institute of Nuclear Physics, Cracow (Poland). 1987. 11p. (In Polish). Order Number DE90633186. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Method of obtaining of Ga-67 from natural zinc by reaction Zn+d was tested. Optimum conditions of irradiation on the U-120 cyclotron were chosen. Ga-67 was separated from the target using isopropyl ether as extractant. The yield of process as well as radionuclidic and chemical purity of preparation were determined. Results were interpreted in terms of applicability for Ga-67 production. 12 refs., 2 figs., 2 tabs. (author).

41243 (JINR-R–6-89-354) **Sorption technique of separation of thallium-201 from proton-irradiated thallium.** Deptula, Cz.; Zajtseva, N.G.; Mikolaevskij, S.; Khalkin, V.A. Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems. 1989. 8p. (In Russian). Order Number DE90633187. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

Submitted to the journal Izotopenpraxis.

A sorption technique is developed for radiochemical separation of thallium-201 from proton-irradiated targets of metallic thallium. The technique consists in separation of ^{201}Pb and ^{201}Tl in the column with ammonium 12-molybdophosphate fixed in the matrix of porous Teflon (AMP-sorbent). The chemical yield of radiothallium is 98 %, the duration of chemical procedures is 2.5-3 hours. 21 refs.; 1 fig.; 1 tab.

41244 (K/CSD/INF–89/42) **The linear solution for hydriding of uranium.** Kirkpatrick, J.R. (Oak Ridge Gaseous Diffusion Plant, TN (USA)); Condon, J.B. Oak Ridge Gaseous Diffusion Plant, TN (USA). [1990]. 11p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC05-84OT21400. (CONF-9009141–2: International symposium on metal-hydrogen systems, Banff (Canada), 2-7 Sep 1990). Order Number DE90012154. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

A set of equations describing the hydriding of solid pieces of uranium is presented, together with an approximate solution of the equations. The solution predicts a constant velocity of the spall front in the solid piece, which leads to a constant value of weight gain rate (or other measure of the extent of the hydriding reaction) for a portion of the duration of the measurement. The solution allows calculation of the spall front velocity, and thus of the constant reaction rate, from expressions that are closed-form with the exception of one simple numerical integration. Expressions are given for all of the parameters needed to calculate reaction rates for well-annealed samples of uranium. Calculated reaction rates are compared with published data taken at a hydrogen pressure of 1.0 atmospheres. The calculated results match the data quite well. 9 refs., 2 figs.

41245 (KFKI–1989-57/J) **Moderation and absorption effects on hot replacement reactions of ^{38}Cl atoms in mixtures of ortho-dichlorobenzene and hexafluorobenzene.** Berei, K.; Gado, J.; Kereszturi, A.; Szatmary, Z.; Vass, Sz. Hungarian Academy of Sciences, Budapest (Hungary). Central Research Inst. for Physics. Oct 1989. 31p. Order Number DE90633153. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Submitted to J. Phys. Chem.

Conditions are given for the equivalence of the Estrup-Wolfgang description of the hot atom-reaction kinetics with the first-order

Hurwitz approximation in the neutron slowing down theory. Conclusions are drawn for the applicability of this approach for describing hot atom replacement processes in reactive mixtures. Analytical and numerical calculations were carried out to explain an unusual concentration dependence of ^{38}Cl-for-Cl substitution, found experimentally in liquid binary mixtures of ortho-dichlorobenzene and hexafluorobenzene. (author) 39 refs.; 4 figs.; 2 tabs.

41246 (LA–11865-PR) **Isotope and Nuclear Chemistry Division annual report FY 1989, October 1988–September 1989.** Los Alamos National Lab., NM (USA). Jun 1990. 122p. Sponsored by U.S. DOE Environment Health & Safety; U.S. DOE Management & Administration. DOE Contract W-7405-ENG-36. Order Number DE90013607. Available from NTIS, PC A06/MF A01 - OSTI; GPO Dep.

This report describes some of the major research and development programs of the Isotope and Nuclear Chemistry Division during FY 1989. The report includes articles on weapons chemistry, biochemistry and nuclear medicine, geochemistry, environmental chemistry, actinide and transition metal chemistry, materials chemistry, nuclear structure and reactions, and INC Division facilities and laboratories.

41247 (ORNL/FTR–2541) **[Lanthanide and actinide organometallic chemistry]: Foreign trip report, April 3, 1987–April 16, 1987.** Payne, G.F. Oak Ridge National Lab., TN (USA). [1987]. 11p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE90012306. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The traveler attended the 2nd ICLA and presented some work on higher oxidation studies of lanthanides and actinides in acetonitrile. Papers of particular interest to ORNL included those on organometallics of both the lanthanides and actinides, recent developments in the theory of f-element molecules and metals, and high temperature studies of "divalent" plutonium. The traveler also visited the Univesity of Lausanne and held discussions involving the purification and drying of numerous organic solvents, the chemistry of electrolytes in organic media and also various spectroscopic techniques for use primarily in non-aqueous media.

4008 Combustion, Pyrolysis, and High-Temperature Chemistry

Refer also to citation(s) 40483, 40951, 41823

41248 (CPIA-PUBL–515-VOL-1, pp. 131-144) **Effect of propellant flowrate and purity on carbon deposition in LO_2/methane gas generators.** Bossard, J.A. (Aerojet TechSystems Co., Sacramento, CA (USA)); Burkhardt, W.M.; Niiya, K.Y.; Braam, F. Johns Hopkins Univ., Baltimore, MD (USA). May 1989. (CONF-8905134–: JANNAF propulsion meeting, Cleveland, OH (USA), 22-25 May 1989). In *The 1989 JANNAF Propulsion Meeting, volume 1.* Available from NTIS, PC A25/MF A04.

The generation and deposition of carbon was studied in the Carbon Deposition Program using subscale hardware with LO_2/Liquid Natural Gas (LNG) and LO_2/Methane propellants at low mixture ratios. The purpose of the testing was to evaluate the effect of methane purity and full scale injection density on carbon deposition. The LO_2/LNG gas generator/preburner testing was performed at mixture ratios between 0.24 and 0.58 and chamber pressures from 5.8 to 9.4 MPa (840 to 1370 psia). A total of seven 200 second duration tests were performed. The LNG testing occurred at low injection densities, similar to the previous LO_2/RP-1, LO_2/propane, and LO_2/methane testing performed on the carbon deposition program. The current LO_2/methane test series occurred at an injection density factor of approximately 10 times higher than the previous testing. The high injection density LO_2/methane testing was performed at mixture ratios between from 0.23 to 0.81 and chamber pressures from 6.4 to 15.2 MPa (925 to 2210 psia). A total of nine high injection density tests were performed. The testing performed demonstrated that low purity methane (LNG) did not produce any detectable change in carbon deposition when compared to pure methane. In addition, the C* performance and the combustion gas temperatures measured were similar to those obtained for pure methane. Similar results were obtained testing pure methane at higher propellant injection densities with coarse injector elements.

41249 (LBL–28884) **The spatial scalar structure of premixed turbulent stagnation point flames.** Shepherd, I.G.; Cheng, R.K.; Goix, P.J. Lawrence Berkeley Lab., CA (USA). Apr 1990. 17p. Sponsored by U.S. Department of Defense; U.S. DOE Energy Research. DOE Contract AC03-76SF00098. Contract F-44620-76-C-0083. (CONF-900704–11: 23. Combustion Institute symposium on combustion, Orleans (France), 22-27 Jul 1990). Order Number DE90014189. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

A high speed tomographic technique is used to quantify the spatial scalar structure of stagnation flow stabilized premixed flames. Studies are performed on CH_4/Air and C_2H_4/Air turbulent flames with equivalence ratios ranging from 0.75 to 1.0. The gas velocity at the nozzle exit is 5 m/s, the turbulence intensity is 7%, the integral length scale 3 mm and hence the turbulence Reynolds number is 70. The light source is a copper vapor laser which produces 20 ns, 5 mJ pulses at a 4 KHz repetition rate. Cylindrical lenses transform the 38 mm circular laser beam to a sheet 50 mm high and 0.6 mm thick. A high speed Fastax camera is used to record the tomographic images formed by the scattering of light from oil droplets seeded in the reactant flow which disappear at the flame front. The films are digitized and the wrinkled flame front extracted from the images by a thresholding technique. The integral scalar length scales proposed in the model of Bray-Champion-Libby are deduced from the tomographic movies by numerically constructing flame crossing sequences from the burned and unburned probability density functions of flame crossing length and performing a spectral analysis of these sequences. The integral scalar length scales are found to be similar to the integral length scales of the incident turbulence. A fractal analysis was performed on the flame boundaries to characterize the flame geometry and provide from an estimate of the flame surface area a measure of the turbulent burning rate. The flame area increase is found to underestimate the turbulent burning velocity when compared with direct measurements of the flow velocity at the cold boundary. 12 refs., 2 tabs.

41250 Two-dimensional imaging of OH in flames by degenerate four-wave mixing. Rakestraw, D.J. (Combustion Research Facility, Sandia National Laboratories, Livermore, California 94551-0969 (USA)); Farrow, R.L.; Dreier, T. *Optics Letters (USA),* 15(12): 709-711 (15 Jun 1990).

Degenerate four-wave mixing is used to produce two-dimensional images of OH distributions in atmospheric-pressure flames. The phase-conjugated images from single laser pulses exhibit excellent signal-to-noise ratios and illustrate that degenerate four-wave mixing has outstanding potential as a multidimensional diagnostic for combustion environments.

41251 A shock tube with tunable, pulsed laser-based diagnostics. Gray, J.A. (Combustion Research Facility, Sandia National Laboratories, Livermore, California 94551-0969 (USA)). *Review of Scientific Instruments (USA),* 61(7): 1825-1831 (Jul 1990). DOE Contract AC04-76DP00789.

This article describes a unique shock tube that is interfaced with a short-pulse, Nd:YAG-pumped, tunable dye-laser system to provide real-time information on transient chemical species. The tube's internal bore (38.1-mm-diam) accomodates 18 optical diagnostic ports. Pressure-driven shock waves are generated in a double-diaphragm driver section and are timed in the driven section by HeNe laser schlieren detectors. Incident shock speeds range between 1000 and 1500 m/s and are reproducible to ± 5 m/s. Individual pulses from the laser and the gate for a photodiode array detector are synchronized with the arrival of shock fronts at the viewing station. Laser-induced fluorescence (LIF) imaging experiments demonstrate the diagnostic power of the new apparatus. One-dimensional (1D) LIF images are recorded in shocked mixtures of ethane, oxygen, and argon by propagating the tunable laser beam along the shock tube's axis and collecting fluorescence from the OH radical on the 1D detector. The detection sensitivity limit for OH by LIF in this shock tube is approximately 4×10^{11} radicals/cm^3 (0.1 ppm).

42 ENGINEERING

4202 Facilities, Equipment, and Techniques

Refer also to citation(s) 40366, 40407, 40440, 40445, 40465, 40779, 41322, 42256

41252 (AD-A-220070/7/XAB) **Water heat pipe frozen startup and shutdown transients with internal temperature, pressure, and visual observation. Final report, September 1984-May 1989.** Reinarts, T.; DeHart, M.; Peery, J.; Best, F. Texas A and M Univ., College Station, TX (USA). Feb 1990. 338p. Available from NTIS, PC A15/MF A02.

Three sets of experiments were performed to analyze the transient nature of heat pipes and possible failures. The first set studied the entrainment phenomenon and suggests that entrainment starts in a form not readily observable by other than visual means. The second set used a specially designed heat pipe with a rectangular cross section, flat mesh-type wick, and a clear top through which internal mechanisms of heat pipe operation could be seen. These served as scoping experiments for the third set. The third set measured vapor space temperatures, wick/liquid temperatures, and internal pressure. A normal start-up experiment, and experiment with step changes in input power levels, including previously unexpected pressure transients and two frozen start-ups, a step decrease in power input to the evaporator, and a steady-state run with decreasing secondary coolant temperature were performed. In addition to the experiments, a multinodal, implicit, finite difference model was developed to simulate heat pipe rapid transients. The mass, momentum, and energy conservation equations generate the velocity, pressure, and temperature profiles. The temperature profiles differed significantly from the experimental data, but the pressure and velocity profiles agree well with existing theory. Computer programs.

41253 (AD-A-220885/8/XAB) **Development of a low-noise 10 K J-T refrigeration system. Technical progress report.** Little, W.A. MMR Technologies, Inc., Mountain View, CA (USA). 15 Feb 1990. 6p. Available from NTIS, PC A02/MF A01.

This report summarizes work done on the development of a low noise Joule-Thomson, microminiature refrigeration system design for 10K operation. Good progress has been made on the compressor and on the waterknife to be used for the fabrication of the refrigerators. Work on the refrigerator itself is progressing well. Difficulties which had been experienced previously resulting in the warming of the nitrogen stage precooler appear to be due to inefficiency of the final stage laminar flow heat exchanger. This inefficiency is strongly dependent upon the mass flow through this stage, and difficulty in controlling this to the required precision caused the wide range of variations in the performance of otherwise similar coolers.

41254 (CONF-9009125-2) **Dielectric-liquid pulsed power switch.** Christophorou, L.G.; Faidas, H. Oak Ridge National Lab., TN (USA). [1990]. 6p. Sponsored by U.S. Department of Defense; U.S. DOE Energy Research. DOE Contract AC05-84OR21400. CONTRACT N00014-89-J-1990. From 10. international conference on conduction and breakdown in dielectric liquids; Grenoble (France); 10-14 Sep 1990. Order Number DE90009425. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Room temperature fast dielectric liquids with electron conduction bands ($V_0 < O$ eV; e.g., neopentane, tetramethylsilane, 2,2,4,4-tetramethylpentane and their mixtures) are electrically-active insulators and have potential as controlled conduction media in pulsed power switching devices. A concept for a dielectric-liquid pulsed power switch employing flash lamps is outlined. 6 refs., 3 figs., 1 tab.

41255 (CRIE-U-89022) **Evaluation method of effective value of accleration of earthquake motion based on slip displacements.** Tochigi, H.; Hirata, K.; Shiojiri, H. Central Research Inst. of Electric Power Industry, Abiko, Chiba (Japan). Sep 1989. 47p. (In Japanese). Order Number DE90507847. Available from NTIS (US Sales Only), PC A03/MF A01.

This paper is concerned with the evaluation of the seismic force due to earthquake motion (EM) in view of the seismic stability of embankments, breakwaters and others. The evaluation is based on a numerical analysis employing a rigid block that slips on a slope as a model of a mass of earth lying on sliding surface (called a sliding moss for brevity). Details of the analysis is given and the results obtained by it are compared with those by the finite element method to show the validity of the use of this simple model. Then the acceleration αA_m is proposed as the quantity representing the effective value of EM, where A_m is the maximum acceleration of EM and alpha is given by the ratio A_y / A_f being less than unity. Here A_y is the minimum acceleration required to cause a model block to slip on a slope and A_f is the maximum acceleration of the EM that forces the block to slip by a certain amount D. It is noted that a sliding mass in EM is generally possible to undergo slip displacement by the amount D without breaking. Taking this fact into account, a discussion is given of the basis for introducing the ratio alpha in the evaluation of the effect that EM produces on a sliding mass. 31 refs., 17 figs., 4 tabs.

41256 (CRIE-U-89024) **Scale effects of wave forces on armor units.** Sakakiyama, T.; Kajima, R. Central Research Inst. of Electric Power Industry, Abiko, Chiba (Japan). Oct 1989. 44p. (In Japanese). Order Number DE90507846. Available from NTIS (US Sales Only), PC A03/MF A01.

This paper first gives a theoretical discussion of the experimental coefficient K_D in Hudson formula, which has been widely used for estimating weight required for an armor unit, based on the equation of the force exerted on the armor unit by wave which is expressed as the sum of drag force and inertia force. It is shown that K_D so far generally taken as constant is inversely proportional to the drag coefficient raised to the three power when inertia force can be neglected and as a result should be considered to be a function of the scale of experiment. Hydraulics experiments are performed using various sizes of armor units ranging from 16g to 6800g in order to confirm the scale effects that follows from the discussion above mentioned. The results are as follows: first, wave forces on armor units relatively increase as the scale of experiment decreases; second, drag forces are dominant compared with inertia force when wave heights are large; third, the scale effects manifested on wave forces are mainly due to change in drag forces. 17refs., 21 figs., 2 tabs.

41257 (DOE/ID/12699-1-Vol.1) **TITAN Legal Weight Truck cask preliminary design report: Volume 1.** Westinghouse Electric Corp., Pittsburgh, PA (USA). Nuclear Services Div. Apr 1990. 435p. Sponsored by U.S. DOE Radioactive Waste Management. DOE Contract AC07-88ID12699. (NWD-TR-025-Vol.1-Rev.2). Order Number DE90013726. Available from NTIS, PC A19/MF A01; OSTI; INIS; GPO Dep.

The Preliminary Design of the TITAN Legal Weight Truck (LWT) Cask System and Ancillary Equipment is presented in this document. The scope of the document includes the LWT cask with fuel baskets; impact limiters, and lifting and tiedown features; the cask support system for transportation; intermodal transfer skid; personnel barrier; and cask lifting yoke assembly. 75 figs., 48 tabs. (KJD)

41258 (DOE/ID/12699-1-Vol.2) **TITAN Legal Weight Truck cask preliminary design report: Volume 2.** Westinghouse Electric Corp., Pittsburgh, PA (USA). Nuclear Services Div. Apr 1990. 626p. Sponsored by U.S. DOE Radioactive Waste Management. DOE Contract AC07-88ID12699. (NWD-TR-025-Vol.2-Rev.2). Order Number DE90013725. Available from NTIS, PC A99/MF A01; OSTI; INIS; GPO Dep.

The Preliminary Design of the TITAN Legal Weight Truck (LWT) Cask System and Ancillary Equipment is presented in this document. The scope of this document includes the LWT cask with fuel baskets, impact limiters, and lifting and tiedown features; the cask support system for transportation; intermodal transfer skid; personnel barrier; and cask lifting yoke assembly. The results of the tradeoff studies and evaluations that were performed during the preliminary design are presented in Appendix A to this report. 51 figs., 17 tabs.

41259 (DOE/ID/12700-1-Vol.1-Rev.1) **Development of NUPAC 140B 100 ton rail/barge cask: Volume 1, Preliminary design report: Revision 1.** Nuclear Packaging Corp., Federal

Way, WA (USA). Apr 1990. 777p. Sponsored by U.S. DOE Radioactive Waste Management. DOE Contract AC07-88ID12700. Order Number DE90013722. Available from NTIS, PC A99/MF A01; OSTI; INIS.

The NuPac 140-B 100 Ton Rail/Barge Shipping Cask Preliminary Design Report (PDR) presents a general introduction to, and description of, the NuPac 140-B Cask and its fuel payload. The NuPac 140-B Cask, Model: NuPac 140-B, is being designed by Nuclear Packaging, Inc., to meet or exceed all NRC and Department of Transportation regulations governing the shipment of radioactive material. Specifically the Cask is being developed as a safe means of transporting spent light-water-reactor (LWR) fuels from existing and proposed reactor facilities to a repository and/or a monitored retrievable storage (MRS) facility. The primary transportation mode is by railroad, although the shipping package is designed to be transported by barge and by truck shipment on a special overweight basis for short distances. This feature allows the servicing of reactor sites and other facilities which lack direct railroad access.

41260 (DOE/ID/12700–1-Vol.2-Rev.1) **Development of NUPAC 140B 100 ton rail/barge cask: Preliminary design report, Volume 2: Revision 1.** Nuclear Packaging Corp., Federal Way, WA (USA). Apr 1990. 545p. Sponsored by U.S. DOE Radioactive Waste Management. DOE Contract AC07-88ID12700. Order Number DE90013723. Available from NTIS, PC A23/MF A01; OSTI; INIS.

The 140-B Cask Ancillary Equipment includes all cask-related hardware necessary for a complete transportation package and for handling of the cask at shipping and receiving facilities. The transportation package equipment includes the cask tiedown system, the railcar and the sunshield/personnel barrier. The cask handling systems include both single and dual load path cask lifting fixtures, a cask uprighting system, an intermodal transfer system, and the cask drain and fill system. This document describes the individual systems in terms of their purpose, their function, and their mechanical features. Structural analyses are provided for the cask lifting and tiedown devices. The cask ancillary equipment will also include special tools and equipment such as seal surface protection device, special torque wrenches, leak test equipment, etc., for handling the cask at a reactor site. Although final design work remains to be completed, the ancillary equipment design information presented in this document ensures that the 140-B cask transportation package will meet or exceed all structural, functional, and operational requirements, within the specified gross vehicle weight limit. 18 figs.

41261 (DOE/ID/12701–1-Vol.2) **Preliminary design report: Babcock and Wilcox BR-100 100-ton rail/barge spent fuel shipping cask: Volume 2.** B and W Fuel Co., Lynchburg, VA (USA). Feb 1990. 317p. Sponsored by U.S. DOE Radioactive Waste Management. DOE Contract AC07-88ID12701. (BW–51-1177082-02-Vol.2). Order Number DE90013717. Available from NTIS, PC A14/MF A01; OSTI; INIS; GPO Dep.

The purpose of this document is to provide information on burnup credit as applied to the preliminary design of the BR-100 shipping cask. There is a brief description of the preliminary basket design and the features used to maintain a critically safe system. Following the basket description is a discussion of various criticality analyses used to evaluate burnup credit. The results from these analyses are then reviewed in the perspective of fuel burnups expected to be shipped to either the final repository or a Monitored Retrievable Storage (MRS) facility. The hurdles to employing burnup credit in the certification of any cask are then outlines and reviewed. the last section gives conclusions reached as to burnup credit for the BR-100 cask, based on our analyses and experience. All information in this study refers to the cask configured to transport PWR fuel. Boiling Water Reactor (BWR) fuel satisfies the criticality requirements so that burnup credit is not needed. All calculations generated in the preparation of this report were based upon the preliminary design which will be optimized during the final design. 8 refs., 19 figs., 16 tabs.

41262 (DOE/ID/12702–1-Vol.1) **Preliminary design report for the NAC combined transport cask: Volume 1.** Nuclear Assurance Corp., Norcross, GA (USA). Apr 1990. 637p. Sponsored by U.S. DOE Radioactive Waste Management. DOE Contract AC07-88ID12702. (NAC-T–89009-Vol.1;DOCKET–71-9231-Vol.1). Order Number DE90013720. Available from NTIS, PC A99/MF A01; OSTI; INIS; GPO Dep.

Nuclear Assurance Corporation (NAC) is under contract to the United States Department of Energy (DOE) to design, license, develop and test models, and fabricate a prototype cask transportation system for nuclear spent fuel. The design of this combined transport (rail/barge) transportation system has been divided into two phases, a preliminary design phase and a final design phase. This Preliminary Design Package (PDP) describes the NAC Combined Transport Cask (NAC-CTC), the results of work completed during the preliminary design phase and identifies the additional detailed analyses, which will be performed during final design. Preliminary analytical results are presented in the appropriate sections and supplemented by summaries of procedures and assumptions for performing the additional detailed analyses of the final design. 60 refs., 1 fig., 2 tabs.

41263 (DOE/ID/12702–1-Vol.2) **Preliminary design report for the NAC combined transport cask: Volume 2.** Nuclear Assurance Corp., Norcross, GA (USA). Apr 1990. 718p. Sponsored by U.S. DOE Radioactive Waste Management. DOE Contract AC07-88ID12702. (NAC-T–89009-Vol.2;DOCKET–71-9231-Vol.2). Order Number DE90013721. Available from NTIS, PC A99/MF A01; OSTI; INIS.

Nuclear Assurance Corporation (NAC) is under contract to the United States Department of Energy (DOE) to design, license, develop and test models, and fabricate a prototype cask transportation system for nuclear spent fuel. The design of this combined transport (rail/barge) transportation system has been divided into two phases, a preliminary design phase and a final design phase. The Preliminary Design Package (PDP) describes the NAC Combined Transport Cask (NAC-CTC), the results of work completed during the preliminary design phase and identifies the additional detailed analyses, which will be performed during final design. This volume contains detailed comments on the NAC-CTC preliminary cask design report as well as specifications and information for the casks.

41264 (EUR–12185) **The removal of concrete layers from biological shields by microwaves.** Hills, D.L. Commission of the European Communities, Luxembourg (Luxembourg). 1989. 42p. Contract FI1D-0040. Available from NTIS (US Sales Only), PC A03/MF A01.

Concrete blocks reinforced with steel bars have been subjected to microwave attack at a frequency of 896 MHz at power levels up to 25 kW. The surface concrete has been explosively removed to the depth of the reinforcement, 10 cm, at a rate of about 2 litres per kWh. Heating was localized around the point of attack, with temperatures up to 300^{0}C at the fractured face being attained. A simple mathematical model of the propagation and absorption of micro-waves was used to estimate the temperature rise of concrete at microwave frequencies of 896 wand 2450 MHz, at different power levels with and without the presence of reinforcing bars. This demonstrated that reinforcement is expected to significantly increase the temperature rise in the concrete between the irradiated surface and the reinforcement, and that near-surface heating should be more rapid at the higher frequency. There was reasonable agreement between predicted and observed temperature at the higher power levels. Further desk and laboratory studies are proposed before proceeding to a fullscale practical demolition machine and the requirements for a prototype remotely-operated demonstration system have been identified. This consists of a static generator of high power (at least 50 kW) transmitting microwaves via a steerable waveguide to a remote applicator mounted on a simple three-axis manipulator capable of traversing realistically large concrete test panels.

41265 (FTINT–43-88) **Effect of the cryocondensate thickness on the radiative characteristics of thermoinsulation screen.** Mikhal'chenko, R.S.; Grigorenko, B.V.; Getmanets, V.F.; Kurskaya, T.A. AN Ukrainskoj SSR, Kharkov (Ukrainian SSR). Fiziko-Tekhnicheskij Inst. Nizkikh Temperatur. 1988. 15p. (In Russian). Order Number DE90632136. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The method and instruments to measure the thickness and refractive index of cryodeposit formed as a result of desublimation from the vaporous mixture in nonstationary regime are described in

details. The solified gas kind was determined according to the refractive index. Effect of cryodeposit thickness on the absorptivity and thermoinsulation screen mirror reflection is analyzed. The importance of consideration of the effects a small thickness water cryodeposit on screen radiative characteristics is underlined. 17 refs.; 5 figs.

41266 (FTINT–48-88) **Problems of cooling and temperature measurement on object in cryogenic optical studies.** Belyaeva, A.I.; Litvishkova, T.G.; Marushko, S.N.; Silaev, V.I.; Sirenko, V.A.; Yur'ev, V.P. AN Ukrainskoj SSR, Kharkov (Ukrainian SSR). Fiziko-Tekhnicheskij Inst. Nizkikh Temperatur. 1988. 33p. (In Russian). Order Number DE90632139. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

An experimental solution of the problem of cooling and reliable temperature measurement on the specimen investigated, which is placed in vacuum within the cooling pipe of an optical cryostat is proposed and scientifically substantiated. Two typical cases are considered, which differ fundamentally both in the source and magnitude of heat influxes to the experimental specimen (ES) and in the technique of the mechanical contact between ES and cold source. The developed realistic models of thermal balance of optical components of the cryostat permit numerical estimation consistent with experimental results. 12 refs.; 7 figs.; 3 tabs.

41267 (N–90-21295) **Liquid transfer cryogenic test facility: Initial hydrogen and nitrogen no-vent fill data.** Moran, M.E.; Nyland, T.W.; Papell, S.S. National Aeronautics and Space Administration, Cleveland, OH (USA). Lewis Research Center. Mar 1990. 28p. (NASA-TM–102572;E–5396;NAS–1.15:102572). Available from NTIS, PC A03/MF A01.

The Liquid Transfer Cryogenic Test Facility is a versatile testbed for ground-based cryogenic fluid storage, handling, and transfer experimentation. The test rig contains two well instrumented tanks, and a third interchangeable tank, designed to accommodate liquid nitrogen or liquid hydrogen testing. The internal tank volumes are approx. 18, 5, and 1.2 cu. ft. Tank pressures can be varied from 2 to 30 psia. Preliminary no vent fill tests with nitrogen and hydrogen were successfully completed with the test rig. Initial results indicate that no vent fills of nitrogen above 90 percent full are achievable using this test configuration, in a 1-g environment, and with inlet liquid temperatures as high as 143 R, and an average tank wall temperature of nearly 300 R. This inlet temperature corresponds to a saturation pressure of 19 psia for nitrogen. Hydrogen proved considerably more difficult to transfer between tanks without venting. The highest temperature conditions resulting in a fill level greater than 90 percent were with an inlet liquid temperature of 34 R, and an estimated tank wall temperature of slightly more than 100 R. Saturation pressure for hydrogen at this inlet temperature is 10 psia. All preliminary no vent fill tests were performed with a top mounted full cone nozzle for liquid injection. The nozzle produces a 120 degree conical droplet spray at a differential pressure of 10 psi. Pressure in the receiving tank was held to less than 30 psia for all tests.

41268 (ORNL/FTR–2607) **[Analytical instrumentation in clinical chemistry]: Foreign trip report, June 23, 1987–July 2, 1987.** Burtis, C.A. Oak Ridge National Lab., TN (USA). 14 Jul 1987. 7p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE90013135. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

As chairman of the Expert Panel on Instrumentation (EPI) of the International Federation of Clinical Chemistry (IFCC), I presided over its closed and open meetings held on June 29, 1987, and July 2, 1987, respectively. As chairman-elect of the Organizing Committee of the 1990 International Congress on Clinical Chemistry, I also attended the meeting of the IFCC Congress Committee to give a progress report. This report was subsequently also presented to the IFCC Executive Board and Council and to its corporate members. These meetings were held prior to, or in conjunction with, the 13th International Congress of Clinical Chemistry. Consequently, I had an opportunity to attend several of the scientific sessions and the Trade Exposition of the Congress.

41269 (PB–90-219619/XAB) **Guidelines for pressure-vessel safety assessment. Special pub. (Final).** Yukawa, S. National Inst. of Standards and Technology, Boulder, CO (USA). Apr 1990. 77p. (NIST/SP–780). Available from NTIS, PC A05/MF A01.

The document presents a technical overview and information on metallic pressure containment vessels and tanks. The intent of the document is to provide OSHA (Occupational Safety and Health Administration) personnel and other persons with information to assist in the evaluation of the safety of operating pressure vessels and low pressure storage tanks. The scope is limited to general industrial application vessels and tanks constructed of carbon or low alloy steels and used at temperatures between -75 and 315 C (-100 and 600 F). Information on design codes, materials, fabrication processes, inspection and testing applicable to the vessels and tanks are presented. The majority of the vessels and tanks are made to the rules and requirements of ASME Code Section VIII or API Standard 620. The causes of deterioration and damage in operation are described and methods and capabilities of detecting serious damage and cracking are discussed. Guidelines and recommendations formulated by various groups to inspect for the damages being found and to mitigate the causes and effects of the problems are presented.

41270 (SAND–89-0874C) **Observations of dynamic stall phenomena on an oscillating airfoil with shear-stress-sensitive liquid crystal coatings.** Reda, D.C. Sandia National Labs., Albuquerque, NM (USA). [1989]. 26p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC04-76DP00789. (CONF-900930–1: 17. International Council of Aeronautical Sciences (ICAS) meeting, Stockholm (Sweden), 9-14 Sep 1990). Order Number DE89013932. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Oscillating airfoil experiments were conducted using shear-stress-sensitive/temperature-insensitive liquid crystal coatings in order to investigate unsteady fluid physics associated with the dynamic-stall process. Laser-light-sheet/smoke-particle flow visualization and surface-mounted micro-tufts were also employed to complement the liquid crystal technique. Experiments were conducted under incompressible flow conditions at a freestream Reynolds number (based on chord) of $\sim 10^6$. Angle-of-attack oscillations of $\pm 19°$ about 0°, at several discrete frequencies, were used to induce the unsteady flows. Boundary layer transition and turbulent separation locations were seen to undergo extensive and rapid movements with changing angle of attack, particularly on the airfoil lee surface. Progression of turbulent separation to the immediate vicinity of the leading edge was observed (via the liquid crystal technique) to result in large-scale, high-frequency fluctuations in the surface shear stress distribution. Comparisons of transition and turbulent separation measurements with Eppler code predictions indicated that the empirically-based viscous flow modeling used in this design tool requires updates. 19 refs., 8 figs., 1 tab.

41271 (SAND–89-7064) **Slotted-wall research with disk and parachute models in the DSMA low-speed wind tunnel.** Van Every, D. (DSMA International, Inc., Mississauga, ON (Canada)); Harris, J.L. Sandia National Labs., Albuquerque, NM (USA); DSMA International, Inc., Mississauga, ON (Canada). Jun 1990. 109p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. Order Number DE90013631. Available from NTIS, PC A06/MF A01 - OSTI; GPO Dep.

A test program investigated the effects of wall open area ratio (OAR) and model axial position on the measured drag of disk and parachute models in a low-speed wind tunnel. The data and discussion presented in this report provide new insight into the nature of slotted-wall interference for bluff bodies in steady flow and give the first quantitative information on nonsteady wall interference and airflow response during the inflation of a parachute. The report concludes that a fixed OAR of between 5% and 15% should eliminate wall interference during inflation and greatly reduce steady-flow interference for geometric blockages up to 15%. Preliminary arguments suggest that an optimum OAR may be found that alleviates wall interference for large models at low speeds while providing for acceptable testing of smaller models in the transonic speed range. 10 refs., 36 figs., 14 tabs.

41272 (SAND–90-0666C) **A 2-dimensional laser radar imaging system for perimeter surveillance.** Cooley, H.T. Sandia National Labs., Albuquerque, NM (USA). [1990]. 16p. Sponsored

by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. (CONF-9007106–23: Institute of nuclear materials management conference, Los Angeles, CA (USA), 15-18 Jul 1990). Order Number DE90013369. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

A 2D-Laser Radar Imaging System consisting of a prototype 2D-Laser Radar Sensor and an Image Processing System is currently being developed as an intrusion detection system capable of immediate detection and quick assessment for perimeter security and surveillance. The objective of this system is to produce a thin laser wall as an invisible intrusion barrier. Since only a small space is needed to create a narrow laser radar wall, this system will work well where there is only limited or narrow zones available to create the secure perimeter. Images are created of objects which penetrate the laser radar wall for assessment and to determine the appropriate alarm response. Such a system can be used to protect against airborne threats from rooftop areas or to guard against ground threats across perimeter zones of critical facilities. This paper will discuss the operational concepts, the technology, and an initial performance of this prototype system. 2 refs., 6 figs.

41273 (SAND–90-0669C) **Radar airspace monitoring system.** Black, B.D.; Skogmo, D.G. Sandia National Labs., Albuquerque, NM (USA). [1990]. 5p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. (CONF-9007106–19: Institute of nuclear materials management conference, Los Angeles, CA (USA), 15-18 Jul 1990). Order Number DE90013874. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Many facilities across America are concerned with the threat of airborne intruders. Many of these sites are near enough to airports to be covered by the FAA radar serving that airport. The radar airspace monitoring system (RAMS) provides the means of attaching to that radar, extracting needed information from it, and sending extracting needed information from it, and sending that information over an ordinary telephone line to the concerned site. At the site, the data are received, processed, and displayed by a computer. The system is designed so that an operator is not required to constantly watch the display. If the computer detects a threat, an alarm sounds. The RAMS consists of two subsystems. One subsystem attaches to the secondary beacon radar, which operates with the transponder installed in most aircraft. The second subsystem attaches to the primary radar, which depends on radio waves reflected from the aircraft. Either subsystem can operate independently, but the combined subsystems, create a more powerful system. With this system the site gains access to a multimillion dollar radar, its maintenance staff, administration, and the buildings required to house them for a modest $15,000 in hardware.m 4 figs.

41274 (SAND–90-0764C) **A secure container for use within glove boxes.** Johnson, S. (International Atomic Energy Agency, Vienna (Austria)); Islam, A.B.M.; Drayer, D.D.; Garcia, M.L.; Tooley, R.D. Sandia National Labs., Albuquerque, NM (USA). [1990]. 5p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. (CONF-9007106–27: Institute of nuclear materials management conference, Los Angeles, CA (USA), 15-18 Jul 1990). Order Number DE90013363. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

At the request of the International Atomic Energy Agency, a Secure Container System (SCS) is being developed by Sandia National Laboratories to provide continuity of knowledge of safeguards items, such as Agency standard weights and safeguards samples, stored within glove boxes. Incorporated into the SCS is the Authenticated Item Monitoring System (AIMS), also developed by Sandia Laboratories. The SCS allows the user to determine if an object stored within the container has been accessed or whether there have been any attempts to tamper with the system. The two components of the system are the Secure Container (SC), which is located within the glove box, and a remote receiver, located outside but nearby the glove box. The SC is comprised of a small battery operated RF transmitter base unit, including a motion-detecting switch, and a secured cover, which fits over the base unit. The SC is made of chemical- and water-resistant material, to allow for use in a corrosive atmosphere. Authenticated data is stored in the receiver and is accessed through the use of a personal computer or a small printer. The computer interface allows the user to view, sort, and print data, while the printer interface gives a summary of alarm events for each SC. 1 ref., 2 figs.

41275 (SAND–90-0771C) **Universal Authenticated Item Monitoring System (AIMS).** Schoeneman, J.L. (Sandia National Labs., Albuquerque, NM (USA)); Jenkins, C.D.; Tooley, R.D.; Warner, B. Sandia National Labs., Albuquerque, NM (USA). [1990]. 5p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. (CONF-9007106–25: Institute of nuclear materials management conference, Los Angeles, CA (USA), 15-18 Jul 1990). Order Number DE90013364. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The Universal Authenticated Item Monitoring Systems (AIMS) will provide the International Atomic energy Agency (IAEA) with a convenient method of monitoring movement of selected items. The system consists of a number of small, battery-powered Sensor/Transmitter (ASTX) packs and a remote Receiver. Each ASTX pact, firmly attached to a selected item, contains a sensitive motion sensor that, when activated, causes the pack to transmit an authenticated RF message to the Receiver. In addition to monitoring item movements, an ASTX pack can be easily converted to detect and report a variety of sensor "Events" including valve actuations, switch closures for door openings, container openings, etc. Periodically, each ASTX pack is required to transmit "State of Health (SOH)" messages to the Receiver, thereby providing assurance that all ASTX packs are operational, and have not been tampered with. The occurrence of motion (or optional switch activations), ASTX enclosure tampering, or missing SOH messages, each comprising an event, is time-tagged and stored by the Receiver for later retrieval during an inspection. The event history can be collected in a stand-along mode utilizing an internal Receiver printer, or by using an IBM-compatible PC that can further process, sort and store the event history for later analysis and archival purposes. The PC provides the inspector with a user-friendly, interactive, menu-driven system for use during installation and collection periods.

41276 (SAND–90-1185) **Techniques for implementing structural model identification using test data.** Allen, J.J.; Martinez, D.R. Sandia National Labs., Albuquerque, NM (USA). Jun 1990. 34p. Sponsored by U.S. DOE Energy Research. DOE Contract AC04-76DP00789. Order Number DE90014746. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Structural system identification methods are analytical techniques for reconciling test data with analytical models. However, for system identification to become a practical tool for engineering analysis, the estimation techniques/codes must communicate with finite element software packages without intensive analyst intervention and supervision. This paper presents a technique used to integrate commercial software packages for finite element modeling (MSC/NASTRAN), mathematical programming techniques (ADS), and linear system analysis (PRO-MATLAB). The parameter estimation techniques and the software for controlling the overall system were programmed in PRO-MATLAB. Two examples of application of this software using measured data are presented. The examples consist of a truss structure in which the model form is well defined, and an electronics package whose model form is ill-defined since it is difficult to model with finite elements. A comparison of the resulting updated models with the experimental data showed significant improvement. 22 refs.

41277 (SAND–90-1247C) **Tensile behavior of borated stainless steels: Phase 1.** Stephens, J.J.; Sorenson, K.B. Sandia National Labs., Albuquerque, NM (USA). [1990]. 16p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. (CONF-900617–17: Pressure vessels and piping conference: be in tune for the 90's, Nashville, TN (USA), 17-21 Jun 1990). Order Number DE90014368. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Borated stainless steel tensile testing is being conducted at Sandia National Laboratories (SNL). The goal of the test program is to provide data to support a code case inquiry to the ASME Boiler and Pressure Vessel Code, Section 3. The adoption by ASME facilitates a materials qualification for structural use in transport cask applications. The borated stainless steel being tested conforms to ASTM specification A-887, which specifies 16 grades of material as a function of boron content (0.20% to 2.25%) and fabrication

technique. For transport cask basket applications, the potential advantage to using borated stainless steel arises from the fact that the structural and criticality control functions can be combined into one material. The test program at SNL involves procuring material, machining test specimens, and conducting the tensile tests. From test measurements obtained so far, general trends indicate that tensile properties (yield strength and ultimate strength) increase with boron content and are in all cases superior to the minimum required properties established in SA-240, Type 304, a typical grade of austenitic stainless steel. Therefore, in a designed basket, web thickness using borated stainless steel would be comparable to or thinner than an equivalent basket manufactured from a typical stainless steel without boron additions. 3 figs., 5 tabs.

41278 (UCRL-JC-103233) **Development of a two-dimensional, electromagnetic, electron fluid computer code for microwave-induced surface breakdown in low-pressure air.** Mayhall, D.J.; Yee, J.H. Lawrence Livermore National Lab., CA (USA). Jun 1990. 6p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-9009192--2: Discharges and electrical insulation in vacuum, Santa Fe, NM (USA), 17-20 Sep 1990). Order Number DE90013287. Available from NTIS, PC A02/MF A01 - OSTI.

A two-dimensional, electromagnetic, electron fluid computer code for microwave-induced surface breakdown in low-pressure air is developed, based on finite difference approximations of Maxwell's equations for TM_{om} modes in cylindrical waveguides and approximate electron conservation equations for continuity with convective terms, momentum, and energy. The code employs collision frequencies for air and an implicit, block-iterative optionally stiff, variable time step solver. A 2.856 GHz, 1 MV/m amplitude, radial electric field pulse in a highly dispersive waveguides impinges on two different, model field emission structures with the same emission threshold (0.2 MV/m) and rate ($10^{11}/m^3$-s). One structure is a perfectly conducting flat end plate; whereas, the other is a perfectly conducting, axial stub of 0.413 cm radius by 1.69 cm length on a flat end plate. In each test case, peak electric fields occur where expected, initial electron generation is by field emission, and later electron generation is by avalanche ionization. The location of peak electron generation is where expected, and the amount of generated electron density varies qualitatively with air pressure as theoretically expected 6 refs., 7 figs., 2 tabs.

4204 Heat Transfer and Fluid Flow

Refer also to citation(s) 40695, 40696, 40697, 40758, 40824, 41006, 41817

41279 (AGARD-CP-468, pp. 13) **Gust response analysis for cascades operating in nonuniform mean flows.** Hall, K.C.; Verdon, J.M. Advisory Group for Aerospace Research and Development (AGARD), 92 - Neuilly-sur-Seine (France). Feb 1990. In *Unsteady Aerodynamic Phenomena in Turbomachines.* Available from NTIS, PC A14/MF A02; Non-NATO Nationals requests available only from AGARD/Scientific Publications Executive.

The linearized unsteady aerodynamic response of a cascade of airfoils subjected to entropic, vortical, and acoustic gusts is analyzed. Field equations for the first-order unsteady perturbation flow are obtained by linearizing the full time-dependent mass, momentum, and energy conservation equations about a nonlinear, isentropic, and irrotational mean or steady flow. A splitting technique is then used to decompose the unsteady velocity field into irrotational and rotational parts leading to field equations for the unsteady entropy, rotational velocity, and irrotational velocity fluctuations that are coupled only sequentially. The entropic and rotational velocity fluctuations can be described in terms of the mean-flow drift and stream functions which can be computed numerically. The irrotational unsteady velocity is described by an inhomogeneous linearized potential equation which contains a source term that depends on the rotational velocity field. This equation is solved via a finite difference technique. Results are presented to indicate the status of the numerical solution procedure and to demonstrate the impact of blade geometry and mean blade loading on the aerodynamic response of cascades to vortical gust excitations. The analysis described leads to very efficient predictions of cascade unsteady aerodynamic phenomena making it useful for turbomachinery aeroelastic and aeroacoustic design applications.

41280 (AGARD-CP-469, pp. 13) **Effects of secondary flow on heat transfer in rotating passages.** Moore, J.G.; Moore, J. Advisory Group for Aerospace Research and Development (AGARD), 92 - Neuilly-sur-Seine (France). Feb 1990. (CONF-8908233--: Conference on unsteady aerodynamic phenomena in turbomachines, Luxembourg (Luxembourg), 28 Aug 1989). In *Secondary Flows in Turbomachines.* Available from NTIS, PC A15/MF A02; Non-NATO Nationals requests available only from AGARD/Scientific Publications Executive.

Secondary flow in rotating cooling passages of jet engine turbine rotors is considered. A Navier-Stokes calculation procedure for turbulent flow is used to compute flow development in a radially outward flow channel, round a sharp 180 degree bend, and in the radially inward flow channel downstream. Areas of high and low heat transfer are explained by secondary flow development and quantitative results show regions of design interest.

41281 (CPIA-PUBL-515-VOL-1, pp. 145-154) **Experimental flow models for SSME flowfield characterization.** Abel, L.C. (Micro Craft, Inc., Tullahoma, TN (USA)); Ramsey, P.E. Johns Hopkins Univ., Baltimore, MD (USA). May 1989. (CONF-8905134--: JANNAF propulsion meeting, Cleveland, OH (USA), 22-25 May 1989). In *The 1989 JANNAF Propulsion Meeting, volume 1.* Available from NTIS, PC A25/MF A04.

Full scale flow models with extensive instrumentation were designed and manufactured to provide data necessary for flow field characterization in rocket engines of the Space Shuttle Main Engine (SSME) type. These models include accurate flow path geometries from the pre-burner outlet through the throat of the main combustion chamber. The turbines are simulated with static models designed to provide the correct pressure drop and swirl for specific power levels. The correct turbopump-hot gas manifold interfaces were designed into the flow models to permit parametric/integration studies for new turbine designs. These experimental flow models provide a vehicle for understanding the fluid dynamics associated with specific engine issues and also fill the more general need for establishing a more detailed fluid dynamic base to support development and verification of advanced math models.

41282 (DOE/ER/25067-2) **A mathematical and numerical study of nonlinear waves arising in a one-dimensional model of a fluidized bed: Progress report, August 16, 1989-August 14, 1990.** Ganser, G.; Christie, I.; Lightbourne, J. West Virginia Univ., Morgantown, WV (USA). Dept. of Mathematics. 14 Apr 1990. 16p. Sponsored by U.S. DOE Energy Research. DOE Contract FG05-88ER25067. Order Number DE90013952. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

We are investigating three mathematical models that describe two-phase flow in a one-dimensional fluidized bed.

41283 (FTINT-20-88) **Pressure losses at forced flow of boiling nitrogen in horizontal channels.** Dolgoj, M.L.; Kirichenko, Yu.A.; Troyanov, A.M.; Shcherbakova, N.S. AN Ukrainskoj SSR, Kharkov (Ukrainian SSR). Fiziko-Tekhnicheskij Inst. Nizkikh Temperatur. 1988. 24p. (In Russian). Order Number DE90632134. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Experimental results on pressure losses at forced flow of two-phase nitrogen in horizontal channels with circular and rectangular cross sections are considered. The effect of pressure, mass velocity and vapor quality at pressure losses are derived. Formulas for predicting friction losses under regime parameters are developed. Dependence of two-phase friction coefficient on mixture velocity are given. 17 refs.; 14 figs.

41284 (FTINT-42-88) **Calculation of vapour bubble dynamics and heat transfer coefficient during nucleate pool boiling of cryogenic liquids in fields of mass forces.** Chernyakov, P.S.; Kirichenko, Yu.A. AN Ukrainskoj SSR, Kharkov (Ukrainian SSR). Fiziko-Tekhnicheskij Inst. Nizkikh Temperatur. 1988. 36p. (In Russian). Order Number DE90632135. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Tehe vapour bubble growth and break off, temperature distribution in the overheated layer during nucleate boiling of liquids are

simulated numerically. A new mechanism of vapour bubble growth is suggested. Analytical relations are given for the heat transfer coefficient and the onset of a developed boiling of liquids. The calculated and measured intrinsic and integral characteristics for boiling nitrogen, oxygen and helium are observed to be in good agreement. 53 refs.; 16 figs.; 7 tabs.

41285 (KFKI–1989-69/G) **Fast and accurate calculation of the properties of water and steam for simulation.** Szegi, Zs.; Gacs, A. Hungarian Academy of Sciences, Budapest (Hungary). Central Research Inst. for Physics. Jan 1990. 51p. Order Number DE90633965. Available from NTIS (US Sales Only), PC A04/MF A01; OSTI; INIS.

A basic principle simulator was developed at the CRIP, Budapest, for real time simulation of the transients of WWER-440 type nuclear power plants. Its integral part is the fast and accurate calculation of the thermodynamic properties of water and steam. To eliminate successive approximations, the model system of the secondary coolant circuit requires binary forms which are known as inverse functions, countinuous when crossing the saturation line, accurate and coherent for all argument combinations. A solution which reduces the computer memory and execution time demand is reported. (author) 36 refs.; 5 figs.; 3 tabs.

41286 (N–90-20426) **Evaluation of an adaptive unstructured remeshing technique for integrated fluid-thermal-structural analysis.** Dechaumphai, P. National Aeronautics and Space Administration, Hampton, VA (USA). Langley Research Center. Feb 1990. 13p. (NASA-TM–102611;NAS–1.15:102611;CONF-900153–: 28. AIAA aerospace sciences meeting, Reno, NV (USA), 8-11 Jan 1990). Available from NTIS, PC A03/MF A01.

An adaptive unstructured remeshing technique is evaluated for integrated fluid-thermal-structural analysis. The technique is combined with the finite element method to solve: (1) the Navier-Stokes equations for high-speed compressible flow; (2) the energy equation for the structural-thermal response; and (3) the quasi-static equilibrium equations for the structural response. The remeshing technique and the analysis solution procedure are described. The effectiveness of the approach is evaluated with two application studies. The flow analysis of Mach 8 shock-shock interference on a three-inch-diameter cylinder is used as the first application study to demonstrate the capability of the remeshing technique and to examine proper remeshing indicators for the inviscid and boundary layer regions. The applicability of the approach for the thermal and structural analyses of the structure is evaluated in the second application study of a 0.25-inch-diameter convectively cooled leading edge subjected to intense aerodynamic heating. Issues associated with remeshing indicators for thermal stress problems are identified.

41287 (N–90-21303) **PROTEUS two-dimensional Navier-Stokes computer code, version 1.0. Volume 1: Analysis description.** Towne, C.E.; Schwab, J.R.; Benson, T.J.; Suresh, A. National Aeronautics and Space Administration, Cleveland, OH (USA). Lewis Research Center. Mar 1990. 71p. (NASA-TM–102551;E–5366;NAS–1.15:102551). Available from NTIS, PC A04/MF A01.

A new computer code was developed to solve the two-dimensional or axisymmetric, Reynolds averaged, unsteady compressible Navier-Stokes equations in strong conservation law form. The thin-layer or Euler equations may also be solved. Turbulence is modeled using an algebraic eddy viscosity model. The objective was to develop a code for aerospace applications that is easy to use and easy to modify. Code readability, modularity, and documentation were emphasized. The equations are written in nonorthogonal body-fitted coordinates, and solved by marching in time using a fully-coupled alternating direction-implicit procedure with generalized first- or second-order time differencing. All terms are linearized using second-order Taylor series. The boundary conditions are treated implicitly, and may be steady, unsteady, or spatially periodic. Simple Cartesian or polar grids may be generated internally by the program. More complex geometries require an externally generated computational coordinate system. The documentation is divided into three volumes. Volume 1 is the Analysis Description, and describes in detail the governing equations, the turbulence model, the linearization of the equations and boundary conditions, the time and space differencing formulas, the ADI solution procedure, and the artificial viscosity models.

41288 (N–90-21306) **PROTEUS two-dimensional Navier-Stokes computer code, version 1.0. Volume 2: User's guide.** Towne, C.E.; Schwab, J.R.; Benson, T.J.; Suresh, A. National Aeronautics and Space Administration, Cleveland, OH (USA). Lewis Research Center. Mar 1990. 110p. (NASA-TM–102552;E–5367;NAS–1.15:102552). Available from NTIS, PC A06/MF A01.

A new computer code was developed to solve the two-dimensional or axisymmetric, Reynolds averaged, unsteady compressible Navier-Stokes equations in strong conservation law form. The thin-layer or Euler equations may also be solved. Turbulence is modeled using an algebraic eddy viscosity model. The objective was to develop a code for aerospace applications that is easy to use and easy to modify. Code readability, modularity, and documentation were emphasized. The equations are written in nonorthogonal body-fitted coordinates, and solved by marching in time using a fully-coupled alternating direction-implicit procedure with generalized first- or second-order time differencing. All terms are linearized using second-order Taylor series. The boundary conditions are treated implicitly, and may be steady, unsteady, or spatially periodic. Simple Cartesian or polar grids may be generated internally by the program. More complex geometries require an externally generated computational coordinate system. The documentation is divided into three volumes. Volume 2 is the User's Guide, and describes the program's general features, the input and output, the procedure for setting up initial conditions, the computer resource requirements, the diagnostic messages that may be generated, the job control language used to run the program, and several test cases.

41289 (N–90-21307) **PROTEUS two-dimensional Navier-Stokes computer code, version 1.0. Volume 3: Programmer's reference.** Towne, C.E.; Schwab, J.R.; Benson, T.J.; Suresh, A. National Aeronautics and Space Administration, Cleveland, OH (USA). Lewis Research Center. Mar 1990. 249p. (NASA-TM–102553;E–5368;NAS–1.15:102553). Available from NTIS, PC A11/MF A02.

A new computer code was developed to solve the 2-D or axisymmetric, Reynolds-averaged, unsteady compressible Navier-Stokes equations in strong conservation law form. The thin-layer or Euler equations may also be solved. Turbulence is modeled using an algebraic eddy viscosity model. The objective was to develop a code for aerospace applications that is easy to use and easy to modify. Code readability, modularity, and documentation were emphasized. The equations are written in nonorthogonal body-fitted coordinates, and solved by marching in time using a fully-coupled alternating-direction-implicit procedure with generalized first- or second-order time differencing. All terms are linearized using second-order Taylor series. The boundary conditions are treated implicitly, and may be steady, unsteady, or spatially periodic. Simple Cartesian or polar grids may be generated internally by the program. More complex geometries require an externally generated computational coordinate system. The documentation is divided into three volumes. Volume 3 is the Programmer's Reference, and describes the program structure, the FORTRAN variables stored in common blocks, and the details of each subprogram.

41290 (ORNL/tr–90/9) **Gas-film flow in tubes.** Blass, E. (Technische Univ. Muenchen (Germany, F.R.). Lehrstuhl A fuer Verfahrenstechnik). Oak Ridge National Lab., TN (USA). 1990. 28p. Translated from Chemie-Ingenieur-Technik (Germany, F.R.); 49, 95-105(1977). Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE90011528. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The countercurrent flow of gases or vapors and falling films is used in many apparatus for thermal treatment or separation. This is because the heat and mass transfer efficiency of such apparatus relative to the expenditure of energy for gas flow and for falling film generation is relatively high compared to that of other separative apparatus. The present article gives an overview of the current possibilities for calculating the flow, heat transfer and mass transfer in falling film apparatus. It discusses steady-state falling film flow with and without the countercurrent flow of gases, the upper and lower operating limit, heat transfer between non-boiling and boiling

falling films and the tube wall, and heat and mass transfer between falling film and the gas. 31 refs., 12 figs., 2 tabs.

41291 (PB–90-220906/XAB) **Gas and liquid maldistributions in packed columns.** Stikkelman, R.M. Academisch Boeken Centrum, Delft (Netherlands). 1990. 109p. Available from NTIS, PC A06/MF A01.

Summary in Dutch.

The study describes the gas and liquid distributions in random as well as structured packings. The experimental column has a diameter of 0.5 m. It is equipped with a total of 1289 detectors in the top and bottom cross section. These detectors yield a detailed picture of air and water flows through elements of only 25x25 sq mm. The observed maldistribution in the gas bulk flow is negligible compared with that of liquid bulk flow. The gas flow rate near the wall equals 1.1-1.3 times the superficial velocity for common 25 mm packings. No influence of the liquid flow rate has been observed. The radial spreading coefficient of the gas is in the order of 4 mm. The liquid flow in the bulk becomes less uniform when the superficial liquid velocity is diminished.

41292 On the forces of droplets in Poiseuille flow. Puri, I.K. (Department of Applied Mechanics and Engineering Sciences, University of California San Diego, La Jolla, California 92093 (USA)); Libby, P.A. *Physics of Fluids A (USA)*, 2(7): 1281-1284 (Jul 1990). DOE Contract FG03-87ER13685.

The forces on droplets in Poiseuille flow in the Reynolds number range from 0.7 to 27 are determined experimentally. It is found that droplets migrate toward the centerline and experience drag considerably in excess of that prevailing in uniform flow. Rough correlations for the drag and lift coefficients as functions of the Reynolds number and a parameter characterizing the flow nonuniformity are developed.

4205 Materials Testing

Refer also to citation(s) 40411, 40436, 40560, 40814, 40815, 41045, 41269, 41321, 41323

41293 (BARC–1472) **Evaluation of bonding in Kamini plate type fuel elements using ultrasonic immersion testing and metallography.** Muralidhar, S. (Bhabha Atomic Research Centre, Bombay (India). Radiometallurgy Div.); Pandey, V.D.; Mahule, K.N.; Prasad, G.J.; Ghosh, J.K.; Ganguly, C. Bhabha Atomic Research Centre, Bombay (India). 1989. 15p. Order Number DE90634033. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Plate type fuel elements have been fabricated for the neutron source reactor 'KAMINI' in the Radiometallurgy Division. These plate fuel elements have been fabricated using the picture frame technique. An important step in the evaluation of the quality of the plate fuel elements is the non-destructive inspection of bonding between the clad plates and the meat and the picture frame. From the available techniques for lack of bond inspection, a choice was made to use the ultrasonic immersion testing technique. This report records the experience gained in the development of the ultrasonic immersion testing technique for the evaluation of bonding in these fuel plates, with a back-up support of metallography. (author). 7 refs., 9 figs.

41294 Three-axes sample manipulator for surface-science experiments in ultrahigh vacuum. Dai, Y. (College of Engineering and Applied Science, State University of New York, Stony Brook, New York 11794 (USA)); Li, H.; Jona, F. *Review of Scientific Instruments (USA)*, 61(6): 1724-1728 (Jun 1990). DOE Contract FG02-86ER45239.

Additions to commercially available manipulators are described which allow independent rotations of a sample in ultrahigh vacuum around three mutually perpendicular axes, as well as *in situ* adjustments of the sample orientation with respect to any of the three rotation axes. The additions allow also the interchange of three different samples *in situ*, with no need for breaking the vacuum in the experimental chamber. The modified manipulator has been successfully tested in experiments involving low-energy electron diffraction and photoemission with synchrotron light for either *s* or *s-p* polarization geometries.

4210 Combustion Systems

Refer also to citation(s) 40347, 40977

4230 Marine Engineering

Refer also to citation(s) 41256

41295 (GKSS–89/E/6) **Application of a seam weld tracking system for robot welding under hyperbar conditions.** Kober, J.; Santos, J.F. dos; Thomas-Jeromin, J.; Szelagowski, P.; Schultheiss, G.; Seeger, G. GKSS-Forschungszentrum Geesthacht GmbH, Geesthacht-Tesperhude (Germany, F.R.). 1989. 8p. (In German). (CONF-8903227–: 3. DSV special meeting: Robots '89 - arc welding, arc cutting, related processes, Fellbach (Germany, F.R.), 8-10 Mar 1989). Available from Special print from DVS-Berichte v. 118, 1989, p. 42-47.

It is reported about first experiences with an optical weld seam tracking system under hyperbar conditions. Thus it was possible in two compression phases of 6 and 31 bar abs to safely weld, for the first time sensor-aided, root passes (weave-bead technique) which would pass the final inspection. (MM).

4260 Components, Electron Devices and Circuits

Refer also to citation(s) 40895, 40979, 40988, 41052, 41071, 41078, 41435, 41436, 41437, 41438, 41497, 41507, 41800, 42098, 42099

41296 (AD-A–219946/1/XAB) **Vertical-emitting, ring-geometry, ultralow-threshold and ultrahigh-speed quantum well lasers for optical interconnect. Report for November 1989-February 1990.** Mittelstein, M.; Bar-Chaim, N. Ortel Corp., Alhambra, CA (USA). Feb 1990. 10p. Available from NTIS, PC A02/MF A01.

The main emphasis during this quarter was placed on: (1) evaluation of structures suitable for vertically emitting ring lasers; (2) fabrication of gratings on non-planar surfaces; (3) presentation at a DoD Fiber Optics Conference. (edc)

41297 (AD-A–219972/7/XAB) **Proof of the feasibility of coherent and incoherent schemes for pumping a gamma-ray laser. Final technical report, 26 September 1986-24 December 1989.** Collins, C.B. Texas Univ., Richardson, TX (USA). Center for Quantum Electronics. Mar 1990. 196p. (UTD-GRL–8903). Available from NTIS, PC A09/MF A02.

Contents: thermal economy of a gamma-ray laser; photoexcitation of nuclear isomers by (gamma, gamma) reactions; adaptation of a fixed energy electron accelerator to produce variable endpoint bremsstrahlung; determination of gateway states in 197au with a compton x-ray spectrometer; calibration of pulsed bremsstrahlung spectra with photonuclear reactions of 77se and 79br; scaling to high average powers of a flash x-ray source producing nanosecond pulses; frequency modulation spectrometer for mossbauer studies; calibration of pulsed x-ray spectra; depopulation of the isomeric state 180ta(m) by the reaction 180ta(m) (gamma, gamma) 180ta; diamond-like carbon films prepared with a laser ion source; activation of 115in(m) by single pulses of intense bremsstrahlung; flash x-ray source excited by stacked blumlein generators; activation of 111 cd(m) by single pulses of intense bremsstrahlung; comment on mossbauer sidebands from a single parent line'; large scale effects of the magnetic phase modulation of recoilles gamma transitions; laser plasma source of amorphic diamond; mossbauer isomer shift measurements without mechanical tuning; and accelerated decay of 180ta(m) and 176lu in stellar interiors through (gamma, gamma) reactions.

41298 (AD-A–220022/8/XAB) **Electron-beam-pumped XeF (C → A) laser scaling. Final report, 1 July 1988-31 December 1989.** Litzenberger, L.N.; Mandl, A.E. Avco Research Lab., Inc., Everett, MA (USA). Feb 1990. 65p. Available from NTIS, PC A04/MF A01.

Efficient operation of the electron beam pumped XeF (C to A) laser under conditions which are scalable to large devices has been demonstrated. A five-component laser gas mixture at a pressure of 2.6 ATM was pumped at a rate of 290 kW/cm^3 with a

600-ns electron beam pulse. The laser gas mixture and output coupler reflectivity were carefully optimized under free-running conditions, and radiation was then injected into the stable cavity from an external flashlamp-pumped dye laser to reduce the flux buildup time to saturation levels. An intrinsic efficiency of 1.8% and a specific output energy of 3 J/l were demonstrated, and a total energy of 4 J was extracted from the e-beam excited medium.

41299 (AD-A-220066/5/XAB) **Spectral properties of a 1.3-micrometers InGaAsP diode laser under direct modulation. Final report, September 1987-February 1988.** Semendy, F.; Katzen, E. Harry Diamond Labs., Adelphi, MD (USA). Aug 1989. 19p. (HDL-TR-2165). Available from NTIS, PC A03/MF A01.

Direct modulation of a buried heterostructure (BH) InGaAsP laser diode was performed up to 18 GHz, and FM properties were observed. The number of lasing modes increased with increasing modulation depth. For a given rf power, the FM index went from 0.7 to 0 as the modulation frequency was increased. These measurements indicate that the nonlinear gain effects mainly influence the modulation characteristics of this laser, and wider bandwidths and modulation indexes can be achieved in this type of multimode device.

41300 (AD-A-220151/5/XAB) **Fundamental processes in superconducting weak links. Final technical report, 1 April 1983-31 December 1988.** Tinkham, M. Harvard Univ., Cambridge, MA (USA). 31 Dec 1988. 14p. Available from NTIS, PC A03/MF A01.

The work accomplished under this contract largely concerns the properties of superconducting weak links, in the form of either small area oxide-barrier tunnel junctions or of SNS weak links, both of which form Josephson junctions. Two reports concern the response of tunnel junctions to far-infrared radiation, 22 elucidating the response under conditions suitable for mixer and detector applications, and 25 identifying the regimes in which chaotic noise makes the driven junction unusable for applications. The second two reports concern the static properties of junctions: 26 dealing with the effect of geometric disorder in large arrays of Josephson junctions, and 27 elucidating the properties of oxide barrier junctions that are so small that the charging energy of a single electron dominates the behavior, causing quantum effects which greatly modify the usual semi-classical Josephson junction properties. Work on high temperature superconductivity was also initiated. A. Far-Infrared Response and Chaos in Small-Area Tunnel Junctions; B. Josephson Junction Arrays with Positional Disorder; C. Novel Quantum Phenomena and Charging Effects in Very Small Tunnel Junctions; and D. High Temperature Superconductivity.

41301 (AD-A-220185/3/XAB) **Microwigglers for submillimeter-wavelength free-electron lasers. Annual report, 1 February 1989-31 January 1990.** Bekefi, G. Massachusetts Inst. of Tech., Cambridge, MA (USA). Plasma Fusion Center. 28 Mar 1990. 21p. Available from NTIS, PC A03/MF A01.

We have designed and tested an electromagnet planar microwiggler for use in free-electron lasers (FELs), constructed of current conductors wound on ferromagnetic cores. A prototype with a period of 1 cm and gap of 0.5 cm produced a peak field on axis in excess of 4.6 kG, with a linear B/H characteristic to about 3.2 kG. The field of each half-period of the wiggler is independently tuneable by adjusting the current delivered to each, thus allowing for precision tuning and/or wiggler tapering. We employ general scaling laws to predict performance of a geometrically similar design with a period of 5 mm.

41302 (AD-A-220216/6/XAB) **Growth, characterization, and applications of laser host and nonlinear crystals.** Khattak, C.P.; Schmid, F.; Wall, K.F.; Aggarwal, R.L. Massachusetts Inst. of Tech., Lexington, MA (USA). Lincoln Lab. 1989. 7p. (MS-8134). Available from NTIS, PC A02/MF A01.

Pub. in The Society of Photo Optical Instrumentation Engineering, Vol. 1104, 95-99(1989).

Titanium-doped $YAlO_3$(Ti:$YAlO_3$) is an attractive candidate for a visible to near-infrared tunable solid-state laser. Un-seeded crystal growth utilizing the heat exchanger method has produced Ti:$YAlO_3$ crystals up to 1-cm in length. Spectroscopic measurements at room temperature showed that the Ti^{3+} absorption peaked at approximately 430 nm and extended from 380 nm to 550 nm. The fluorescence emission peaked at 600 nm and extended from 540 nm to 800 nm. No detectable parasitic absorption was observed in the 600-800 nm region; the figure of merit was estimated to be in excess of 15 as compared to previously reported values of 1.5 to 3. The lifetime of the excited state was measured to be 11.4 + or - 0.5 microseconds. In this work lasing was not observed because of pump-induced excited-state absorption in our crystals, presumably arising from charge transfer transitions to energy levels of defects, and not because of parasitic absorption.

41303 (AD-A-220227/3/XAB) **Gain mass transport and GaInP/GaAs buried-heterostructure lasers.** Groves, S.H.; Liau, Z.L.; Palmateer, S.C.; Walpole, J.N. Massachusetts Inst. of Tech., Lexington, MA (USA). Lincoln Lab. 22 Jan 1990. 4p. (JA-6386). Available from NTIS, PC A01/MF A01.

Pub. in Applied Physics Letter, Vol. 56, No. 4, 312-314(22 Jan 1990).

Mass transport of a semiconductor alloy has been demonstrated using Ga(0.51)In(0.49)P which is lattice matched to Gallium Arsenide. Buried-heterostructure diode lasers with Ga(0.51)In(0.49)P as cladding and GaAs as the active layer have been made using this fabrication technique. Initial attempts produce devices with room-temperature lasing thresholds of approx. 33 mA and 15% differential power efficiency per facet.

41304 (AD-A-220271/1/XAB) **Research studies on extreme-ultraviolet and soft x-ray lasers. Annual report, 1 September 1988-31 August 1989.** Harris, S.E.; Young, J.F. Stanford Univ., CA (USA). Edward L. Ginzton Lab. 28 Mar 1990. 17p. Available from NTIS, PC A03/MF A01.

The overall purpose of this program has been to study the physics, technology, and spectroscopy of extreme ultraviolet (XUV) and soft x-ray lasers. The objective of the work was to develop a class of fixed frequency and tunable lasers whose wavelengths span the 100 A to 1000 A spectral region. Of special interest was developing incoherent, laser driven, harder x-ray sources that operate on a femtosecond time scale, and which could be used both for time resolved x-ray spectroscopy and, ultimately, for the pumping of solid state, micron dimension, x-ray lasers. Work on XUV and soft x-ray lasers began about ten years ago with the use of high peak power microwaves to produce metastable, non-autoionizing core-excited species. The work has proceeded on both the spectroscopic and the laser fronts. Section 2 lists the principal accomplishments in these areas.

41305 (AD-A-220276/0/XAB) **Semiconductor laser theory with many-body effects.** Haug, H.; Gayg, G.; Koch, S.W. Arizona Univ., Tucson, AZ (USA). Optical Sciences Center. 15 Feb 1989. 14p. Available from NTIS, PC A03/MF A01.

Pub. in Physical Review A, Vol. 39, No. 4, 1187-1898(15 Feb 1989).

A description of the electron-hole plasma of a semiconductor laser is developed that includes the many-body effects due to the Coulomb interactions. In particular, the plasma density-dependent band-gap renormalization, the broadening due to intraband scattering, and the Coulomb enhancement are included and evaluated for three- and two-dimensional semiconductor structures. Because of the short intraband scattering relaxation time one can eliminate the interband polarization adiabatically and at the same time introduce a hydrodynamic description of the interband kinetics. From this general formulation a diffusion equation for the carrier density is derived. The resulting ambipolar diffusion coefficient decreases with the laser intensity due to the reduction of the electron drift. The present semiclassical theory is completed by the laser field equations and by the addition of Langevin fluctuations.

41306 (AD-A-220290/1/XAB) **Fast-plasma mixing: A new excitation method for C-W lasers. Final report, 1 May 1986-31 October 1989.** Schaefer, G.; Kirkici, H. Polytechnic Univ., Farmingdale, NY (USA). Weber Research Inst. 15 Mar 1990. 64p. (POLY-WRI-1573-90). Available from NTIS, PC A04/MF A01.

Resonant and near-resonant energy and charge transfer collisions to molecules are effective mechanisms to generate population inversions in gas lasers. A new technique (fast plasma

mixing) has been developed in which metastables and ions are generated separately in a flowing plasma source and then mixed with a molecular beam. Two CW systems, based on a flowing hollow cathode and a constricted arc have been designed. Experiments with several molecular systems have demonstrated selective excitation of atoms, molecules, molecular ions, and excimers. Spectroscopic investigations allowed determining branching ratios and the geometric distribution of the excitation in the mixing volume. CW laser action was achieved in oxygen and fluorine and experiments were performed to clarify the excitation mechanisms First experiments on ArF and KrF excimer generation were performed and the fluorescence profiles were investigated depending on operating parameters.

41307 (AD-A–220326/3/XAB) **Effect of gain nonlinearities on the dynamic response of single-mode semiconductor lasers.** Agrawal, G.P. Rochester Univ., NY (USA). Inst. of Optics. Dec 1989. 5p. Available from NTIS, PC A01/MF A01.

Pub. in IEEE Photonics Technology Letter, Vol. 1, No. 12, 419-421(Dec 1989).

The effect of gain nonlinearities on the dynamic response is studied by using a nonperturbative form of the nonlinear gain in the signal-mode rate equation. The nonperturbative form is different from that used previously and leads to qualitative and quantitative differences in the intensity dependence of the important dynamic parameters such as the frequency and the damping rate of relaxation oscillations. The results are important for the design of high-speed semiconductor lasers and suggest that the new form of the nonlinear gain should be used for modeling the modulation response in both the small-signal and large-signal regimes.

41308 (AD-A–220421/2/XAB) **Effects of wiggler errors on free-electron laser performance. Memorandum report.** Esarey, E.; Marable, W.; Tang, C.M. Naval Research Lab., Washington, DC (USA). 2 Apr 1990. 25p. (NRL-MR–6597). Available from NTIS, PC A03/MF A01.

The effects of random wiggler magnetic field errors on free electron lasers is analyzed analytically and computationally. Wiggler field errors perturb the electron beam as it propagates and lead to a random walk of the beam centroid delta x as well as cause deviations in the parallel beam energy delta gamma parallel and in the relative phase of the electrons in the ponderomotive wave delta psi. The phase deviation delta psi is identified as the single most important parameter characterizing the detrimental effects of wiggler errors. In order to avoid significant reduction in gain it is necessary for the phase deviation to be small compared to pi. It is shown that transverse focusing of the electron beam is not effective in reducing the phase deviation (i.e., transverse focusing reduces the average phase deviation by 1/2). Furthermore, it is shown that the results of beam steering at the wiggler entrance reduces the average phase deviation at the end of the wiggler by 1/3. The detrimental effects of wiggler errors may be reduced by arranging the magnet poles in an optimal ordering such that the magnitude of the phase deviation is minimized.

41309 (AD-A–220448/5/XAB) **Many-body effects in gain and refractive-index spectra of bulk and quantum-well semiconductor lasers. Report for 1 July-31 December 1989.** Ell, C.; Haug, H.; Koch, S.W. Arizona Univ., Tucson, AZ (USA). Optical Sciences Center. 1 Apr 1989. 5p. Available from NTIS, PC A01/MF A01.

Pub. in Optics Letters, Vol. 14, No. 7, 356-358(1 Apr 1989).

Gain and refractive-index spectra for bulk and quantum-well semiconductor lasers are computed using quantum-mechanical many-body theory. The results clearly show the influence of band-gap renormalization, broadening, and Coulomb enhancement on the gain, the absorption, and the refractive-index spectra.

41310 (AD-A–220749/6/XAB) **Research on short-wavelength free-electron lasers. Final report, 6 December 1985-5 December 1987.** Berkeley Research Associates, Inc., CA (USA). Feb 1988. 119p. Available from NTIS, PC A06/MF A01.

The research involved in the theoretical and numerical analysis of the physics of free electron lasers using relativistic particle beams. The major emphasis of the research was to obtain design criteria for the development of a two-stage FEL oscillator operating in the trapped particle mode, and for a UV-FEL operating in an oscillator configuration with an intense CO2 laser beam as a pumping source instead of the usual wiggler field. In order to carry out this program it is necessary to provide an appropriate model for the radiation physics of both types of FEL's, to examine the relevant nonlinear wave-particle dynamics, and to model the characteristics, development and evolution of the associated electron beam.

41311 (AD-A–220750/4/XAB) **Collective free-electron laser theory. Final report, 30 October 1985-30 July 1986.** Colson, W.B. Berkeley Research Associates, Inc., CA (USA). Aug 1988. 51p. Available from NTIS, PC A04/MF A01.

The long-pulse induction linac is considered for the first stage of a two-stage free electron laser (FEL) oscillator. This research effort studies several effects that can significantly influence the performance of such an FEL. The FEL is parameterized in a set of dimensionless variables that can summarize several physical effects without the use of detailed calculation as well as relating the physical to other FEL designs. A waveguide analysis shows the primary modifications on the FEL interaction, electron beam distribution functions representing energy spread and emittance are evaluated in the high gain regime, and a multimode analysis of the trapped-particle instability is performed for parameters describing the FEL. The research in intended to extend the simulation theory of high-gain FEL oscillators. In the two-stage FEL, the first-stage uses a normal FEL interaction with the usual static undulator to produce an intense electromagnetic wave in a high-power resonator. The wavelength in the first stage is around 1 cm, and provides the periodic undulator in the second stage of the interaction. The electromagnetic undulator has a shorter wavelength with a more intense field than can be attained from a static magnetic field, and allows the second stage to reach short optical wavelengths with a low energy electron beam.

41312 (CRIE-T–89015) **Analysis of three-dimensional eddy current field.: Aplication to calculation of magnetic screening effect of the damper system in a model superconducting generator.** Kawamoto, T.; Takuma, T.; Akita, S. Central Research Inst. of Electric Power Industry, Komae, Tokyo (Japan). Energy and Environment Lab. Nov 1989. 28p. (In Japanese). Order Number DE90507869. Available from NTIS (US Sales Only), PC A03/MF A01.

Based on the formulation proposed by Emson and Simkin, a method of calculating eddy current is given which uses a modified magnetic vector potential in conducting region whereas a magnetic scalar potential in non-conducting region. Only the stationary field of alternating current expressed by complex number is dealt with and the code of calculation is established based on the finite element method. Applying this code to the calculation of eddy current generated in a bollow cylinder and a square plate being placed in homogeneous magnetic field, the results are compared with those calculated by the other method or an exact solution to show the validity of the present code. Then of the damper near the center of a model superconducting generator the relation between its slip frequency and its magnetic screening effect is dealt with by this code. The result is in fairly good agreement with that obtained by experiment or calculated by the other method. Finally the result of calculation is given of three-dimensional eddy current induced on the inside wall of innermost SUS layer situated at the inner damper of the generator. 9 refs., 15 figs., 3 tabs.

41313 (IYaF–88-160) **Interfaces for a simple local network.** Nekhanevich, Eh.L.; Yasenev, M.V. AN SSSR, Novosibirsk (USSR). Inst. Yadernoj Fiziki. 1988. 31p. (In Russian). Order Number DE90634242. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

A system of communication and interfaces for a simple local network of computers is described. The data on technical parameters, fields of application and operation features of the interfaces developed are presented. The data indispensable for the development of software are given. The experience in operation of the subsystem of software for remote terminal computers which makes use of the above interfaces is briefly presented. 7 refs.; 3 figs.

41314 (JINR–8-89-210) **Experimental study of the nuclotron magnet cool-down and warm-up processes.** Vladimirova, N.M.

(and others); Drobin, V.M.; D'yachkov, E.I. Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy. 1989. 8p. (In Russian). Order Number DE90632140. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

A circuit of the experimental setup is escribed. The results of the study of cool-down process for a single magnet, string of two and four magnets as well as warm-up process for a single magnet are presented. The test data which are necessary for calculation and the following choice of the nuclotron magnet system cool-down and warm-up modes have been obtained. 6 refs.; 5 figs.

41315 (KEK–89-21) **Proceedings of the 4th workshop on RF superconductivity.** Kojima, Y. (ed.). National Lab. for High Energy Physics, Tsukuba, Ibaraki (Japan). Jan 1990. 910p. (CONF-8908239–: 4. workshop on RF superconductivity, Tsukuba (Japan), 14-18 Aug 1989). Order Number DE90508149. Available from NTIS (US Sales Only), PC A99/MF A01.

Composed of two volumes.

This issue is the collection of the papers presented at the title meeting. The 38 of the presented papers are indexed individually. (J.P.N.).

41316 (LA-UR–90-1848) **Chip breaking and control for a precision automated turning system.** Burnham, M.W. (BDM International, Inc., McLean, VA (USA)); Abbatiello, L.A. Los Alamos National Lab., NM (USA). [1990]. 25p. Sponsored by U.S. DOE Management & Administration. DOE Contract W-7405-ENG-36 ;AC05-84OR21400. (CONF-9009155–1: Advanced machining technology III, Chicago, IL (USA), 11 Sep 1990; Y/DX–1118). Order Number DE90012155. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Chip breaking and control is essential to automatic operation of precision turning systems. Failure to transfer parts and system jams can occur if chip fragments are not continuously removed. Surface damage and tool breakage also result from chips that are permitted to wrap around the tool. Also, with increasing environmental concerns, chip handling and recycling are becoming major issues in manufacturing. New information on a variety of mechanisms for breaking chips and methods for removal from the system are discussed. Some of the chip breaking methods are evaluated for the range of cutting in which they are effective. Chip curl and chip breaking analyzed carefully by Nakayama and others is expanded to more fully understand the ways in which chips can be broken. 23 figs.

41317 (MLM–3644(OP)) **Evaluations of new polyimide films for flexible circuit applications at EG&G Mound Applied Technologies.** Williams, M.K. (EG and G Mound Applied Technologies, Miamisburg, OH (USA)); Huelskamp, M.; Brandon, J.; Fisher, M.; Smith, A.; Wittberg, T. EG and G Mound Applied Technologies, Miamisburg, OH (USA). [1990]. 7p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-88DP43495. (CONF-9006121–7: 4. international SAMPE electronic materials and processes conference, Albuquerque, NM (USA), 12-14 Jun 1990). Order Number DE90014117. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Until recently, flexible cable development and production at Mound had to rely heavily on Kapton polyimide from Dupont. The availability of new polyimide films has provided the opportunity to evaluate alternatives to Kapton for our flexible cable work. This paper describes the initial evaluations of the Upilex polyimides, Upilex-S, R, and SGA, distributed by ICI and Apical polyimide distributed by Allied Signal. The new polyimide films were analyzed, along with Kapton, by scanning electron microscopy/energy dispersion spectroscopy, infrared spectroscopy, and x-ray photoelectron spectroscopy. Relative insulating strengths of the films were determined by high voltage electrical breakdown (HiPot) test. All the films were given a thin metal coating by physical vapor deposition, and the metal to polyimide adhesion was tested. Actual test cables were made using Upilex-S as a bridge material. These cables were fired and flyer performance was compared to that of flyers made from Kapton. The new polyimide films not only compare well to Kapton in all areas but also show some advantages in certain applications. 2 figs., 3 tabs.

41318 (PB–90-203746/XAB) **Multibeam semiconductor laser.** Tamura, H.; Okada, M.; Suzuki, H. Toshibe Corp., Tokyo (Japan). Principal Office. ©1989. 4p. Available from NTIS, PC A06/MF A01.

Text in Japanese. Included in Toshiba Review, Vol. 44, No. 12, 969-971(1989).

The authors have succeeded in minimizing thermal crosstalk between laser diode elements in a monolithic array of two individually addressable inner-stripe lasers, each emitting 780-nm-10-mW CW. This has been achieved by means of a junction-down mounting on a semi-insulative Si submount with patterned electrodes on its surface. The thermal crosstalk is about half that of the conventional junction-up mounting over the range of distances examined (30-100 micro m) between the diode elements. Preliminary results obtained with a three-element array have shown that this mounting method possesses advantages in the fabrication of multi-element arrays.

41319 (PB–90-203753/XAB) **MOSFET coupler.** Aizawa, Y.; Sekiwa, T.; Miyasaka, H. Toshibe Corp., Tokyo (Japan). Principal Office. ©1989. 4p. Available from NTIS, PC A06/MF A01.

Text in Japanese. Included in Toshiba Review, Vol. 44, No. 12, 984-986(1989).

One of the newest innovations to enter the photocoupler market is the MOSFET coupler. This coupler incorporates two MOSFET devices that are directly driven by a photovoltaic device. Among the advantages of this type of coupler arrangement are a high input to outpout insulation voltage, low-driving power, and high-speed response to input signals. There are several reasons for these advantages, of which the following are two of the principal factors: (1) The LED used in the device is a double-heterostructure GaAlAs high-efficiency infrared LED; and (2) The photovoltaic device is fabricated using Toshiba's silicon wafer direct bonding (SDB) technology. This coupler has a large range of applications, including for both AC and DC signals even at very small currents and analog signals. This capability to be used with a wide range of signals enables the coupler to be employed instead of a mechanical relay in circuit designs.

41320 (PB–90-869389/XAB) **Double heterostructure used in diode lasers and light emitting diodes. January 1972-March 1990 (A Bibliography from the COMPENDEX data base). Report for January 1972-March 1990.** National Technical Information Service, Springfield, VA (USA). May 1990. 129p. Available from NTISPC N01/MF N01.

Supersedes PB–84-851146.

This bibliography contains citations concerning the application of a double heterostructure or double heterojunction in the construction of semiconductor lasers and light emitting diodes (LED's). Topics include a discussion of crystal growth and doping, fabrication methods, and overall laser and LED design and construction. Performance data for a variety of double heterostructure devices is also included. (This updated bibliography contains 317 citations, 106 of which are new entries to the previous edition.)

41321 (SAND–90-1359) **Characterization and development report for the SA3262, a high voltage rectifier diode.** Holck, D.K. Sandia National Labs., Albuquerque, NM (USA). 29 May 1990. 50p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. Order Number DE90013616. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This report documents the development and testing of the SA3262, a high voltage rectifier diode, manufactured by Microsemi. 13 figs., 4 tabs.

41322 (UCRL–100330) **COP Gage error budget.** Thompson, D.C. Lawrence Livermore National Lab., CA (USA). 25 Aug 1988. 25p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-9009117–1: Certification of process gage design review meeting, Livermore, CA (USA), 20-21 Sep 1990). Order Number DE90008899. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The error budget for the COP Gage is based in part on similar budgets generated for two earlier LLNL projects: The Large Optics Diamond Turning Machine (Donaldson,1979), and the Dual Transducer Gage (Thompson et al, 1985). As with these previous efforts, we need to start with a set of assumptions relating to the treatment

of individual error sources, the combinatorial rules by which individual errors will be incorporated into the overall budget, and those categories of errors which will be included (or excluded) in the formulation of the budget. 3 tabs.

41323 (UCRL–102516) **Cathode applications to high-current diodes.** Pincosy, P.A.; Poulsen, P.; Greenwood, D. Lawrence Livermore National Lab., CA (USA). 31 May 1990. 5p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-9006179–4: 5. national conference on high-power microwave technology, West Point, NY (USA), 10-15 Jun 1990). Order Number DE90013290. Available from NTIS, PC A02/MF A01 - OSTI.

A principal limitation of pulse length for high electron current density diodes is the gap closure due to plasma propagation. This closure is due to plasma formed on the cathode and anode in the process of explosive field emission created by the required high field stresses of the high current diode. Experimental results of high current density "T-F" cathode and a plasma cathode will be presented. Current densities of greater than 300 A/cm2 were obtained for pulse lengths of 3 μsec. Typical closure velocities were less than 2 mm/usec compared with the typical 2 cm/μsec for explosive emission cathodes. 4 refs., 7 figs.

41324 Sideband instabilities in free electron lasers. Rosenbluth, M.N. (Institute for Fusion Studies, The University of Texas at Austin, Austin, TX (USA)); Vernon Wong, H.; Moore, B.N. *Physics of Fluids B (USA)*, 2(7): 1635-1653 (Jul 1990). DOE Contract FG05-80ET53088.

The linear stability of sideband modes for a one-dimensional free electron laser is investigated in detail. The dependence on wiggler taper, slippage between optical pulse and electrons, and trapped electron distribution functions are included in the analysis. Nyquist plots are used to delineate the parameter space in which sideband instabilities occur and approximate analytic expressions for the linear growth rate are derived. In special cases a complete analytic solution is given. Essentially all equilibria are unstable to sideband growth. The linear growth rates agree well with numerical simulations.

41325 Observation of nondissipative quasiparticle tunnel currents in superconducting tunnel junctions. Hu, Q. (Department of Physics, University of California, Berkeley, Berkeley, California 94720 (USA)); Mears, C.A.; Richards, P.L.; Lloyd, F.L. *Physical Review Letters (USA)*, 64(24): 2945-2948 (11 Jun 1990). DOE Contract AC03-76SF00098.

We have made the first direct measurement of the quantum susceptance which arises from the nondissipative part of the quasiparticle tunneling in a superconductor-insulator-superconductor (SIS) junction. The resonant frequency of a resonator which contains an SIS junction depends on the dc bias due to the bias dependence of the quantum susceptance. The observed 19% shift of the resonant frequency, form 73 to 87 GHz, is in excellent agreement with the Werthamer-Tucker theory. This quantum susceptance should exist in other devices such as quantum-well structures.

41326 Theory of 1/*f* magnetic flux noise in high-T_c superconductors. Wang, L. (Solid State Science Center, Department of Physics University of California, Los Angeles, Los Angeles, California 90024 (USA)); Zhu, Y.; Zhao, H.L.; Feng, S. *Physical Review Letters (USA)*, 64(25): 3094-3097 (18 Jun 1990). DOE Contract FG03-88ER45378.

A theoretical model is proposed to explain the magnitude of excess 1/*f* magnetic flux noise in high-T_c superconducting SQUID's. Based on a model for 1/*f* noise generation due to the multiple elastic scattering of quasiparticles with disordered mobile vortices, we show that the 1/*f* flux noise magnitude has the following features: It increases with T below T_c, sharply falls off with T above T_c, and decreases with an increasing energy gap. Its magnetic-field dependence is also shown to be inversely proportional to the square of the voltage-to-flux transfer function. Our results are shown to be in good agreement with recent experimental measurements.

41327 Calculation of universal scaling function for free-electron-laser gain. Yu, L.H. (National Synchrotron Light Source, Brookhaven National Laboratory, Upton, NY (USA)); Krinsky, S.; Gluckstern, R.L. *Physical Review Letters (USA)*, 64(25): 3011-3014 (18 Jun 1990). DOE Contract AC02-76CH00016.

We present a variational calculation of free-electron-laser gain the exponential regime before saturation using a dispersion relation incorporating the energy spread, emittance, and focusing of the electron beam, and the diffraction and guiding of the radiation. Rapid computation facilitates free-electron-laser design optimization. Results are expressed in a universal scaled form.

43 PARTICLE ACCELERATORS

Refer also to citation(s) 42055

4301 Design, Development, and Operation

Refer also to citation(s) 41362, 41364, 41370, 41380, 41401, 41484, 42239

41328 (BARC–1467) **Realistic edge field model code REFC for designing and study of isochronous cyclotron.** Ismail, M. (Variable Energy Cyclotron Centre, Calcutta (India)). Bhabha Atomic Research Centre, Bombay (India). 1989. 45p. Order Number DE90633972. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The focussing properties and the requirements for isochronism in cyclotron magnet configuration are well-known in hard edge field model. The fact that they quite often change considerably in realistic field can be attributed mainly to the influence of the edge field. A solution to this problem requires a field model which allows a simple construction of equilibrium orbit and yield simple formulae. This can be achieved by using a fitted realistic edge field (Hudson et al 1975) in the region of the pole edge and such a field model is therefore called a realistic edge field model. A code REFC based on realistic edge field model has been developed to design the cyclotron sectors and the code FIELDER has been used to study the beam properties. In this report REFC code has been described along with some relevant explaination of the FIELDER code. (author). 11 refs., 6 figs.

41329 (IFVE-OLU–89-115) **Method of statistical studying of linac tolerances.** Shulaev, G.A. Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Serpukhov (USSR). Inst. Fiziki Vysokikh Ehnergij. 1989. 4p. (In Russian). Order Number DE90633973. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

The mthod of statistic processing for calculation data of dynamics in accelerator beam channel with accidental errors is proposed. Two groups of tolerances have been obtained. The first group has a strong effect on the beam emittance, the second one has weak effect. 2 refs.; 1 tab.

41330 (KEK–89-12, pp. 9-25) **Electron accelerator in U.S.A. present status and future planning.** Hotta, Akio (Shizuoka Univ. (Japan)). National Lab. for High Energy Physics, Tsukuba, Ibaraki (Japan). Sep 1989. (In Japanese). (CONF-8810498–: Workshop on the experiments by polarized proton and electron beams, Tsukuba (Japan), 27-28 Oct 1988). In *Proceedings of the workshop on the experiments by polarized proton and electron beams.* Order Number DE90777829. Available from NTIS (US Sales Only), PC A11/MF A01.

The electron accelerator facilities in U.S.A. for medium energy nuclear physics are reviewed. MIT-Bates Linear Accelerator Center: The present status of the recirculator, the experimental equipment, the South Hall Ring project (Stretcher Ring) which is now under construction, and the polarized electron source are reported. SLAC, Nuclear Physics at SLAC (NPAS): The character of electron beams in the End Station A for nuclear physics and the experimental equipment in the End Station A are reviewed. CEBAF (Continuous Electron Beam Accelerator Facility); The design of the accelerator with 100 % duty factor using a superconducting CW linac, the experimental equipment (magnets) in the three experimental halls (A, B, and C), and the planning for experimental programs are presented. (author).

41331 (ORNL/FTR–3665) **[Recent developments at the Holifield Heavy Ion Research Facility]: Foreign trip report, June 9, 1990–June 21, 1990.** Olsen, D.K. Oak Ridge National Lab., TN (USA). 16 Jul 1990. 13p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE90014310. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The traveler attended the European Particle Accelerator Conference in Nice, France, on June 12–16, 1990, and presented the paper "Recent Developments at the Holifield Heavy Ion Research Facility." All aspects of European accelerator operation, construction, and development were discussed at this conference. It seemed as if very few new European accelerator projects were under serious study. The traveler also visited the ECR ion source group at Grenoble, France, and found them very willing to participate in the development of an ECR source for the HHIRF tandem accelerator. The MIMAS ring at Saclay, France, is very similar to the HISTRAP proposal in terms of hardware and provides an important source of information on the required technologies.

41332 (SAND–90-1938C) **RLA [Recirculating Linear Accelerator] accelerating cavity improvements.** Smith, D.L.; Johnson, W.A.; Turman, B.N.; Bennett, L.F. Sandia National Labs., Albuquerque, NM (USA). [1990]. 7p. Sponsored by U.S. Department of Defense; U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. (CONF-9006228–1: 1990 annual charged particle beam meeting, San Diego, CA (USA), 11-14 Jun 1990). Order Number DE90014567. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

In the Recirculating Linear Accelerator, we will inject a 10-kA to 20-kA electron beam, and then focus and guide it with an IFR plasma channel, which is created with a low energy electron beam. The REB will be transported through a closed racetrack or a spiral beam line to be re-accelerated by the ringing waveform of dielectric cavities. By adding more accelerating cavities along the beam line, high energies can be achieved. Experiments are in progress to study IFR beam transport issues. A new injector is needed for beam re- acceleration experiments. We are presently installing this new REB injector which will-provide a higher amplitude (~4 MV), longer duration (~40-ns FWHM), more rectangularly shaped(~25-ns full width at 90% peak) waveform and a colder beam than were achievable with the previous 1.5-MV injector. The resultant constant beam energy can be more efficiently matched the guiding IFR plasma channel in the beam line and to the turning section magnetic fields. We are now developing new cavities that produce accelerating voltage pulses with improved waveform flatness, width, and amplitudes that do not suffer unacceptable degradation over the first four ringing periods. This effort requires network solver and electrostatic field stress analysis computer codes, and a scaled test model to compare actual waveforms to those predicted by the simulations. 10 refs., 9 figs.

41333 (SSC–2) **SSC [Superconducting Super Collider] aperture workshop summary.** Lawrence Berkeley Lab., CA (USA). SSC Central Design Group. Nov 1984. 133p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-89ER40486. (CONF-8411327–Summ.: SSC aperture workshop, Berkeley, CA (USA), 5-9 Nov 1984). Order Number DE90014005. Available from NTIS, PC A07/MF A01; OSTI; INIS; GPO Dep.

The SSC Aperture Workshop was held November 5-9, 1984 at Lawrence Berkeley Laboratory. The workshop focused on issues related to the selection of an optimum aperture for the SSC. Aperture is a critical issue at this early stage of design, because it strongly affects both the construction cost and the satisfactory commissioning and operation of the collider. The workshop had a double purpose: To design a course of action for determining the needed physical and dynamic aperture and commensurate magnetic field specifications of a high luminosity proton collider with a beam energy of 20 TeV, and to prepare a proposal for carrying out the recommended R&D program in two steps – a four-month intensive phase to provide knowledge essential for conceptual design and magnet selection, and a longer term effort to supply details and ultimately to support the construction, commissioning, and operation of the new collider. To accomplish these objectives, the participants met in the following working groups, each led by a coordinator, which are discussed in this paper: test lattices; aperture requirements; magnet errors; formats, data bases, networks and lattice codes; tracking codes; analytical screening; and experiments on existing machines.

41334 (SSC–3) **Aperture Task Force report.** Superconducting Super Collider Lab., Dallas, TX (USA). 17 Dec 1984. 22p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-89ER40486. Order Number DE90014112. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

The SSC Aperture Workshop held on Nov. 5–9, 1984 at LBL has identified the most immediate work that needed to be done in order to make a preliminary aperture evaluation by next spring. The Workshop proposed an action plan, complete with time schedule and [illegible] assignments, to carry out the work. An Aperture Task Force that consists of the coordinators of the working groups was formed after the Workshop to coordinate the execution of the action plan. The Task Force therefore consists of: test lattices; aperture requirements; magnet errors; format, database, network and lattice codes; improving tracking/lattice codes; analytic screening; and experiments. These tasks are reviewed in this report.

41335 (SSC–5) **Workshop on SSC commissioning and operations: Interim report.** Lawrence Berkeley Lab., CA (USA). SSC Central Design Group. 28 Jan 1985. 65p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-89ER40486. Order Number DE90014113. Available from NTIS, PC A04/MF A01; OSTI; INIS.

As a step toward deciding upon the magnet type most appropriate for the SSC, a workshop was held at UC Berkeley during the week of 14 January 1985 to study the impact of magnet design on commissioning and operating the SSC. The main objects of the workshop were to form a fairly complete list of the commissioning/operations implications of each magnet type, and organize the continuing work of a task force, which will produce a final report by early April, 1985. This interim report essentially summarizes the results of the workshop, which in many cases is just an enumeration of problems to be studied in the coming weeks, together with lists of task force members who have agreed to report upon them.

41336 (SSC–15) **Superconducting Super Collider siting parameters document: A technical advisory on SSC site criteria and catalog of site information needs.** Lawrence Berkeley Lab., CA (USA). SSC Central Design Group. 15 Jun 1985. 48p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-89ER40486. Order Number DE90014108. Available from NTIS, PC A04/MF A01; OSTI; INIS; GPO Dep.

The Superconducting Super Collider, or SSC, is a proposed scientific instrument for the study of the fundamental nature of matter. In the SSC two 20-TeV beams of protons will be accelerated and counter circulate on an approximately circular path. The protons will be made to collide at six locations where detectors can be placed to count and measure the products of the collisions. These collisions, twenty times more energetic than in any existing facility, will enable scientists to probe deeper into the heart of matter in the quest for a deeper understanding of the universal forces of nature. The goal of the SSC project is to create a scientific laboratory in high energy physics whose facilities are unique. Ultimately the success of that laboratory will be measured by its scientific discoveries, measurements, interpretations, and innovations. Toward that end the accelerator-collider must be constructed to high standards at minimum cost and maximum effectiveness. Preparations must be made for future operations and a scientific-technical staff attracted and maintained. The chosen site must accommodate all of these factors. This document summarizes siting criteria for the SSC and enumerates site-specific information important to the evaluation of potential sites. This document is not a call for site proposals but a technical report prepared for the information and use of the Department of Energy (DOE).

41337 (SSC–19) **Superconducting Super Collider (SSC) test lattice designs.** Courant, E.D. (Brookhaven National Lab., Upton, NY (USA)); Douglas, D.R.; Garren, A.A.; Johnson, D.E. Lawrence Berkeley Lab., CA (USA). SSC Central Design Group.

[1990]. 4p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-89ER40486. Order Number DE90014109. Available from NTIS, PC A02/MF A01; OSTI; INIS.

Simple test lattices for a 20 TeV superconducting super collider have been designed based on each of the major dipole designs, 3, 5, 6, and 6.5 Tesla. These lattices have been made as nearly identical as possible. The reason for different lattices is to be able to evaluate equally the different magnet designs, with associated multiple distributions and persistent current errors, through analytical and tracking programs without the complications of different lattice designs. It should be noted that while these designs are typical of a 20 TeV SSC, they are meant only for study and do not represent a machine which would be built. Thus, they do not have crossing magnets or utility insertions. However special phase shifting sections called Phase Trombones are included, a feature not present in most of the previous SSC lattice designs.

41338 (SSC–27) **Tevatron operational experience and implications for SSC [Superconducting Super Collider] aperture.** Harrison, M. (Fermi National Accelerator Lab., Batavia, IL (USA)). Lawrence Berkeley Lab., CA (USA). SSC Central Design Group; Fermi National Accelerator Lab., Batavia, IL (USA). 19 Apr 1985. 19p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-89ER40486 ;AC02-76CH03000. Order Number DE90014086. Available from NTIS, PC A03/MF A01; OSTI; INIS.

In this report we shall endeavor to extract some information from the recent fixed target running period of the Tevatron. We choose to look primarily at injection effects since these are expected to be similar in both machines and thus relatively direct statements can be made on aperture which do not involve complex arguments. The process of transferring the beam from the injector to the main accelerator is a point in the machine cycle which involves a relatively complex sequence of operations, and as such one would intuitively expect aperture demands to be placed on the accelerator which are different from those encountered at other times in the operation of the SSC. In this report we shall endeavor to look at this aspect of machine performance taking a rather empirical approach for reasons that hopefully will become apparent.

41339 (SSC–31) **Accelerator physics studies for the SSC [Superconducting Super Collider].** Chao, A.W. Lawrence Berkeley Lab., CA (USA). SSC Central Design Group. [1985]. 6p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-89ER40486. Order Number DE90014088. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

In the spring of 1984, a reference designs study (RDS) was carried out to identify the issues and to provide a crude cost estimate of the SSC. Following the RDS, a Central Design Group was formed in October to perform the detailed design R&D for construction of the SSC. This paper is a brief review of progress made on the accelerator physics studies since October 1984. For major issues not discussed here, many of them of great importance, the RDS report is still the valid source of information. 29 refs., 6 figs.

41340 (SSC–33) **Where is the SSC today?.** Tigner, M. Lawrence Berkeley Lab., CA (USA). SSC Central Design Group. [1990]. 5p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-89ER40486. Order Number DE90014103. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

The SSC is a high luminosity pp collider designed to achieve 40 TeV in the center of mass. Depending on the final magnetic field chosen the main ring will be between 90 and 165 km in circumference. Construction of the SSC has been recommended to the DOE by HEPAP for completion in the early 1990's. The Universities Research Association has been designated by the DOE to do R/D and prepare a design proposal, construction plan and cost estimate. Model magnets are being tested and a field level will be chosen before October 1985. A design proposal will be submitted in April 1986. 4 refs., 6 figs., 2 tabs.

41341 (SSC–34) **Civil aspects of the SSC.** Sanford, J.R. Lawrence Berkeley Lab., CA (USA). SSC Central Design Group. [1990]. 5p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-89ER40486. Order Number DE90014094. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

The Reference Designs Study (RDS) of the Superconducting Super Collider (SSC) came to a conclusion in May 1984. During the course of the study, the design team had shown the feasibility of designing and constructing an SSC. An important element in the overall project concerned the physical plant for the new research laboratory. About 1/3 of the approximately $3 billion cost estimate was devoted to the construction of the tunnels, buildings and conventional facilities for the project. The SSC is planned to be constructed in less than six years following the development phase, currently, estimated to end in October 1987. This paper will briefly review the civil systems that were developed during the course of the RDS. The technical features of the SSC led to a consideration of the siting needs and criteria. The criteria that have been suggested to DOE will be briefly described. Finally, the study and design work to be undertaken in the next couple years is outlined including a brief exploration of issues and problems.

41342 (SSC–35) **Accelerator systems of the SSC [Superconducting Super Collider].** Limon, P. Lawrence Berkeley Lab., CA (USA). SSC Central Design Group. [1990]. 4p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-89ER40486. Order Number DE90014090. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

The Accelerator Systems Division (ASD) of the SSC is primarily concerned with the technical components of the main collider rings. The division is not directly responsible for the superconducting magnets, but the detailed design of the magnet package is strongly influenced by the designs of the other technical systems. Table 1 is a list by work breakdown of the major subsystems for which the ASD has responsibility. Those subsystems shown in parentheses are ones that are not the direct responsibility, but require considerable design input from the ASD. In this paper, we outline the objectives and tasks of the ASD during the R&D phase of the SSC project, present the proposed organization of the division, and discuss the R&D work that is presently taking place.

41343 (SSC–49) **Accelerator physics in Superconducting Super Collider (SSC) design.** Chao, A.W. Lawrence Berkeley Lab., CA (USA). SSC Central Design Group. [1985]. 17p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-89ER40486. (CONF-8505405–1: 1985 annual DPF conference, Eugene, OR (USA), 13-16 May 1985). Order Number DE90014010. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

An elementary description of the accelerator physics considerations encountered in the design of the Superconducting Super Collider is presented. An attempt has been made to introduce the terminology and the basic physics issues from a user's point of view. 15 refs., 12 figs., 1 tab.

41344 (SSC–54) **Radiation safety of the Superconducting Super Collider.** Jones, L.W. Michigan Univ., Ann Arbor, MI (USA). Apr 1986. 39p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-89ER40486. Order Number DE90014002. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

The Superconducting Super Collider (SSC) is planned to be a basic research facility providing beams of 20 TeV (trillion electron volt) protons in two counter-rotating orbits which intersect at six points. The proton beams are guided by high-field, superconducting magnets around an oval path 52 miles in circumference. The purpose of this paper is to identify, quantify, and discuss the various sources of ionizing radiation and the measures which are planned to accommodate them in order to protect both the general public and the staff of the SSC laboratory. These sources and the measures to deal with them are well understood from the experience of existing accelerator facilities. In spite of the differences in energy, the radiation protection requirements and the level of difficulty in meeting them for the SSC are very similar to those for the existing facilities. The proposed SSC as described in the April 1986 Conceptual Design Report and other, reports of the Central Design Group will consist of four basic components: and injector complex of four cascaded accelerators roughly similar to Fermilab's Tevatron, in which protons will be accelerated from rest to about 1 TeV; the collider ring, whose circumference will be about 52 miles, the experimental areas; and the campus/laboratory area. 27 refs., 9 figs., 10 tabs.

41345 (SSC–55) **Ground motion tolerances for the SSC [Superconducting Super Collider].** Fischer, G.E. (Stanford Linear Accelerator Center, Menlo Park, CA (USA)); Morton, P. Lawrence Berkeley Lab., CA (USA). SSC Central Design Group; Stanford Linear Accelerator Center, Menlo Park, CA (USA). Jan 1986. 30p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-89ER40486 ;AC03-76SF00515. (SLAC-PUB–3870). Order Number DE90014000. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

We attempt in this note to make plausibility arguments regarding the magnitude of tolerable ground motions for the SSC. A complete, general and quantitative treatment of every conceivable effect awaits far more effort than could have been marshalled for this preliminary study. This note is in three parts: a description of the types of motions likely to be encountered on any site and some generally obvious site recommendations; estimates of the consequences of such motions with calculations of only those few types which we consider dominant in the problem (a review of the type and strength of beam position feedback which may be required); and a summary of suggested tolerances resulting from the calculations and assumptions made. 16 refs., 5 figs., 3 tabs.

41346 (SSC–81) **Lattice of the SSC.** Garren, A.A. Lawrence Berkeley Lab., CA (USA). SSC Central Design Group. Aug 1986. 4p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-89ER40486. (CONF-860870–23: 13. international conference on high energy accelerators, Novosibirsk (USSR), 7-11 Aug 1986). Order Number DE90014657. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

The lattice design of the Superconducting Super Collider Conceptual Design Report is presented. The machine has two vertically separated rings and two diametrically opposite clusters of experimental and utility straight sections. The lattice, characterized by compactness, modularity and optimization of phase intervals between long straight sections, may be flexibly tuned for injection and for different experimental requirements. Cell, experimental and utility straight section, and dispersion suppressor designs are described, as well as chromatic properties for various operational conditions. 6 refs., 8 figs.

41347 (SSC–83) **Conventional facilities considerations in the configuration of a major accelerator laboratory.** Toohig, T.E. Lawrence Berkeley Lab., CA (USA). SSC Central Design Group. Aug 1986. 4p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-89ER40486. (CONF-860870–22: 13. international conference on high energy accelerators, Novosibirsk (USSR), 7-11 Aug 1986). Order Number DE90014236. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

Configuration studies for conventional facilities associated with major accelerators involving communications, maintenance and operations can have significant impact on overall design. A proposed revision to the Test Beam Facility at the Facility at the SSC is given as an example. 4 figs.

41348 (SSC–85) **Accelerator physics issues in large proton storage rings.** Peggs, S. Lawrence Berkeley Lab., CA (USA). SSC Central Design Group. Aug 1986. 8p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-89ER40486. (CONF-860870–21: 13. international conference on high energy accelerators, Novosibirsk (USSR), 7-11 Aug 1986). Order Number DE90014241. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

A review of some accelerator physics issues which have arisen during the design of the Superconducting Super Collider (SSC) is broken down into the following topics: Primary Constraints, Magnet Style and Orientation, Cell Parameter Optimization, Interaction Region Optics, Beam-Beam Effects, Dipole Field Errors, Tracking Tools, and Global and Local Correction Schemes. 36 refs., 11 figs., 2 tabs.

41349 (SSC–98) **Dependence of coherent instabilities and parasitic heating on vacuum chamber radius for the SSC.** Lee, Huan; Chattopadhyay, S. Lawrence Berkeley Lab., CA (USA). SSC Central Design Group. Sep 1986. 16p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-89ER40486. Order Number DE90014045. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

The impedance budget for SSC may have to be changed as a result of optimization of the cell lattice and aperture design. We have investigated the impact on the collective instabilities and parasitic heating if the vacuum chamber radius differs from the CDR value by as much as ± 0.5 cm. We conclude that the corresponding changes on the cryogenic load due to parasitic heating are small, and the most of the CDR conclusions on the collective instabilities remain intact. The requirements for the feedback gain and Landau damping to stabilize the transverse multibunch are modified somewhat, but can be met easily. 9 refs.

41350 (SSC–110) **Preliminary simulations of the neutron flux levels in the Fermilab tunnel and proposed SSC tunnel.** Gabriel, T.A. (Oak Ridge National Lab., TN (USA)); Alsmiller, F.S.; Alsmiller, R.G. Jr.; Bishop, B.L.; Hermann, O.W.; Groom, D.E. Lawrence Berkeley Lab., CA (USA). SSC Central Design Group. 20 Aug 1987. 27p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-89ER40486. Order Number DE90014041. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

In the fall of 1985, a FNAL/LBL group measured neutron spectra in the Tevatron tunnel. During the machine cycle just ended, these experiments were refined and extended. Absolute magnitude and longitudinal distributions of the neutron flux were measured down the tunnel from a warm section in the beam pipe. A controlled N_2 gas leak was introduced near the center of the warm section, so that by measuring rates as a function of gas pressure, beam-gas rates could be separated from background rates. To help support this experimental effort, detailed simulations of particle cascades in the Fermilab tunnel initialed by hadron-nucleus collisions in the center of the warm section were carried out using a version of HETC. The MORSE code was used to transport the low-energy neutrons. In this note, preliminary results from these simulations are presented, as well as results calculated at SSC energies, i.e., at 20 TeV. The simulations will become more detailed as the experimental analysis proceeds, and the feedback obtained from the experiment will allow further improvements in the transport capabilities. Final reports detailing both calculational and experimental results will be published.

41351 (SSC–136) **The Superconducting Super Collider.** Jackson, J.D. Lawrence Berkeley Lab., CA (USA). SSC Central Design Group. Aug 1987. 9p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-89ER40486. (CONF-870632–21: International Europhysics conference on high energy physics, Uppsala (Sweden), 25 Jun - 1 jul 1987). Order Number DE90014658. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

This paper discusses the design and development of the Superconducting Super Collider. (LSP)

41352 (SSC–146) **The 90° (September 1987) SSC [Superconducting Super Collider] lattice.** Garren, A.A.; Johnson, D.E. Lawrence Berkeley Lab., CA (USA). SSC Central Design Group. Sep 1987. 113p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-89ER40486. Order Number DE90014554. Available from NTIS, PC A06/MF A01; OSTI; INIS; GPO Dep.

The lattice design of the 90° (September 1987) SSC lattice is described. Plots show the structure and orbit functions of the lattice components, output from the SYNCH program give parameter values and orbit functions for injection and collision optics, tables and plots are given for the tuning between the two optical configurations, and output from the MAD program provides geometrical survey data.

41353 (SSC–147) **A guide to understanding the radiation environment of the Superconducting Super Collider (SSC).** Coulson, L. (Fermi National Accelerator Lab., Batavia, IL (USA)); Freeman, W.; Toohig, T. Fermi National Accelerator Lab., Batavia, IL (USA). Nov 1987. 37p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-89ER40486. (FN–468). Order Number DE90014654. Available from NTIS, PC A03/MF A01; OSTI; INIS.

This report discusses: accelerators; radiation; radiation from accelerator operations; calculation and control of radiation from accelerator operations; radiation considerations in the design of the SSC; and reporting requirements and historical records.

41354 (SSC–164) **A possible new design of the SSC boosters.** Chen, L.K.; Furman, M.A. Lawrence Berkeley Lab., CA (USA). SSC Central Design Group. Nov 1988. 61p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-89ER40486. Order Number DE90014651. Available from NTIS, PC A04/MF A01; OSTI; INIS; GPO Dep.

A new design for the lattices of the SSC's three injectors is presented and compared with the CDR. The complex is matched so that the SSC filling factor is 94%, and is designed so that there is no transition crossing at any point. In general, the dispersion function is substantially reduced relative to the CDR design, and it is made to vanish in the straight sections. We also present tracking results which include the effect of the space-charge force, chromatic sextupoles, synchrotron oscillations, and the expected random and systematic dipole magnet errors. We conclude that the CDR magnet design allows adequate dynamic aperture for all three boosters, and that the space-charge force in the LEB has no significant detrimental effect provided the LEB is tuned properly. 15 refs., 25 figs., 5 tabs.

41355 (SSC–192) **Supercollider!.** Quigg, C. Lawrence Berkeley Lab., CA (USA). SSC Central Design Group. Oct 1988. 20p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-89ER40486. (CONF-8711344–1: Ecole la physique des particules, Palaiseau (France), 18 Nov 1987). Order Number DE90013780. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

This paper discusses the design and uses of the superconducting super collider. (LSP)

41356 (SSCL–212-Rev.) **Ground-motion effects on the SSC: Revision.** Ng, King-Yuen (Lawrence Berkeley Lab., CA (USA). SSC Central Design Group); Peterson, J. Lawrence Berkeley Lab., CA (USA). SSC Central Design Group. Jan 1990. 44p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-89ER40486. (FN–511-Rev.). Order Number DE90014648. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

Ground motion at the one-micron level can seriously degrade the collider performance. Motion of the quadrupole magnets is the main concern. Because of the high magnetic gradients in the quadrupoles, a small horizontal or vertical motion can result in a significant change in the central (closed) orbit in each of the two rings. Furthermore, for a proton-proton collider, the orbit changes in the two rings are different because the quadrupoles are arranged asymmetrically in the two rings – i.e., a focusing quadrupole in one ring always occurs with a defocusing quadrupole in the other ring. As a consequence, at each of the four collision points, the changes in the two closed orbits due to ground motion are likely to be different, thus causing the two beam centers to miss each other with a consequent reduction in luminosity. In this report we examine these effects quantitatively for plane waves, for spreading waves from point sources, and for waves from a distribution of point sources, such as a train, but in an ideal, uniform, and semi-infinite model of the SSC site. More data on ground motion and attenuation effects at the actual SSC site are certainly needed. 8 refs., 12 figs., 1 tab.

4302 Beam Dynamics, Field Calculations, and Ion Optics

Refer also to citation(s) 41328, 41333, 41334, 41338, 41339, 41343, 41348, 41352, 41429, 41448, 41449, 41806

41357 (AD-A–220603/5/XAB) **Intense pulsed-ion-beam neutralization focusing and collective plasma interactions. Doctoral thesis.** Kraft, R. Cornell Univ., Ithaca, NY (USA). Aug 1985. 5p. Available from NTIS, PC A01/MF A01.

The purpose of this thesis is to study the propagation of an intense pulsed ion beam in certain environments. Three areas of ion beam propagation are studied: charge and current neutralization by electrons when a beam is injected into a vacuum region; focusing of a beam when it is axially injected into a solenoidal magnetic lens; and collective interactions when a beam passes through a background hydrogen plasma. The experimentally observed beam behavior in each of these situations is analyzed and compared with theoretical models. In the experiment, a beam (360 keV., 65 amps/sq cm, 150 ns.) was extracted from a planar, magnetically insulated diode and injected into a field free vacuum region. The beam was found to be both charge and current neutralized by electrons drawn axially into the beam from the cathode of the diode. The neutralization process was modelled with a theory which predicts the velocity distribution of the comoving neutralizing electrons.

41358 (BNL–43678) **Evolution of longitudinal equilibrium distribution in the adiabatic regime.** Wei, J.; Lee, S.Y.; Ruggiero, A.G. Brookhaven National Lab., Upton, NY (USA). [1990]. 3p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76CH00016. (CONF-900603–25: 2. European particle accelerator conference, Nice (France), 11-16 Jun 1990). Order Number DE90013738. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

Evolution of longitudinal equilibrium distribution of a hadron bunch under the beam-environment interaction is investigated based on a self-consistent solution of the Vlasov equation. The effect of this interaction on the distribution can be characterized by a dimensionless quantity in analogy to the one describing the microwave-instability criterion. In the case that the coupling impedance (Z/n) is reactive and frequency independent, the change in the distribution results in a stabilization that keeps the bunch below the instability threshold; microwave instability is thus eliminated. Monte Carlo simulation for the microwave instability agrees with analytic solution of the Vlasov equation provided that bunch shape distortion due to the coupling is taken into account.

41359 (BNL–52246) **Control of non-linear space-charge emittance growth.** Gallardo, J.C. Brookhaven National Lab., Upton, NY (USA). [1990]. 8p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76CH00016. Order Number DE90014752. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

A simple analytical model of the space-charge (self-fields) of a few picosecond electron pulse in a RF photocathode electron gun is presented. The model permits a search for the optimal laser distribution (transverse and longitudinal) that will result in an electron beam with minimum transverse emittance. It is concluded that electron distributions with sharp edges in the transverse dimension and parabolic (inverted) in the longitudinal direction are best to minimize the emittance. These effects have been confirmed with extensive simulations using the numerical code PARMELA. 9 refs., 5 figs., 1 tab.

41360 (DOE/ER/40374–25) **Research in accelerator physics (THEORY): Final technical report, May 15, 1988–May 14, 1989.** Ohnuma, Shoroku. Houston Univ., TX (USA). Aug 1989. 10p. Sponsored by U.S. DOE Energy Research. DOE Contract FG05-87ER40374. Order Number DE90014354. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

This report discusses: recurrence of KAM tori in nonanalytic twist maps; Arnold diffusion in three-degrees-of-freedom Hamiltonian systems; beam-beam interaction and pacman effects; systematic treatment of isolated nonlinear difference resonance; correction of nonlinear effects by magnet sorting; optimization of linac injector system; self consistent treatment of space charge effects in low- energy boosters; development of improved beam dynamics treatment for compact synchrotrons; and improvement of the tevatron performance at Fermilab.

41361 (DOE/ER/40374–32) **Beam transport in the crystal x-ray accelerator.** Tajima, T. (Texas Univ., Austin, TX (USA)); Newberger, B.S.; Huson, F.R.; Mackay, W.W.; Covington, B.C.; Payne, J.; Mahale, N.K.; Ohnuma, S. Houston Univ., TX (USA). [1989]. 6p. Sponsored by U.S. DOE Energy Research. DOE Contract FG05-87ER40374. (CONF-890803–53: International conference on high energy accelerators, Tsukuba (Japan), 20-26 Aug 1989). Order Number DE90014357. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

A Fokker-Planck model of charged particle transport in crystal channels which includes the effect of strong accelerating gradients has been developed for application to the crystal x-ray accelerator and other crystal accelerator schemes. We indicate the implications of the analytic solutions found for a harmonic channeling potential

for the accelerating gradient and the multiple scattering which, because we consider only the acceleration of positive particles, is dominated by scattering from the valence electrons. In order to relax the constraints imposed by these, we have been exploring the application of novel materials to this problem. One candidate is porous Si and our investigation into this material which is as yet preliminary is discussed and other possible materials are indicated.

41362 (DOE/ER/40374–36) **Research in accelerator physics (theory): Progress report, May 15, 1989–December 31, 1989.** Ohnuma, Shoroku. Houston Univ., TX (USA). 1 Jan 1990. 84p. Sponsored by U.S. DOE Energy Research. DOE Contract FG05-87ER40374. Order Number DE90014358. Available from NTIS, PC A05/MF A01; OSTI; INIS; GPO Dep.

This report discusses: Arnold diffusion; recurrence of KAM Tori; Beam-beam Interaction; Isolated Difference Resonances and Particle Distribution; correction schemes of Nonlinear Effects; analysis of E778 Data: resonances in two-degrees-of-freedom; optimization of Linac Injector System; low energy Transport Helical Electrostatic Quadrupoles; Space Charge Problems in Low-Energy Booster Synchrotrons; development of improved beam dynamics treatment for Compact Synchrotrons; operation of Tevatron near Integer Tunes. LSP

41363 (DOE/ER/40374–39) **Space charge effects in low energy synchrotrons.** Machida, Shinji. Texas Accelerator Center, The Woodlands, TX (USA). [1990]. 4p. Sponsored by U.S. DOE Energy Research. DOE Contract FG05-87ER40374. (CONF-900603–25: 2. European particle accelerator conference, Nice (France), 11-16 Jun 1990). Order Number DE90014356. Available from NTIS, PC A02/MF A01; OSTI; INIS.

We have studied space charge effects in low energy proton synchrotrons using a simulation code developed specifically for supercomputers. The tracking of the beam with a few thousand macro particles is completely self-consistent, thus making it possible to follow the charge distribution as well as the beam size as a function of time. A proper substitution of the kick for the continuous space charge force has been considered. The simulation is performed for a model lattice with and without half integer resonances. In the lattice with the resonances, the phase space density limit is observed as expected. However, the limiting value is not directly related to the Laslett tune shift of individual particles. If we look at individual particles, there is a bare tune region where the real tune of some particles modified by space charge is within the resonance width. In the lattice without half integer resonances, the rms emittance growth is associated with higher order resonances driven by the beam itself. Only the tail of the beam is affected by the resonance, and the phase space density at the core remains almost unchanged.

41364 (DOE/ER/40374–40) **Research in accelerator physics (theory): Final technical report, May 15, 1989–May 14, 1990.** Ohnuma, Shoroku. Houston Univ., TX (USA). 30 Jun 1990. 15p. Sponsored by U.S. DOE Energy Research. DOE Contract FG05-87ER40374. Order Number DE90014359. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

This report discusses: beam-beam interaction and pacman effects in the SSC with momentum oscillation; Two-parameter sorting of dipoles in large synchrotrons; self-consistent treatment of space charge effects in low energy synchrotrons; new acceleration scheme in RFQ; low beam transport helical electrostatic quadrupole; improved beam dynamics treatment for compact synchrotrons; and analysis of E778 data on coupled resonances by sextupoles. (LSP)

41365 (JINR–9-89-300) **Investigation of the coupling resonance in the AIC-144 cyclotron.** Schwabe, J. (Institute of Nuclear Physics, Cracow (Poland)); Borisov, O.N.; Kol'ga, V.V. Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems. 1989. 6p. (In Russian). Order Number DE90633985. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

The results of numerical investigations of the effect of the nonlinear coupling resonance on the free oscillations amplitude in AIC-144 isochronous cyclotron are presented. The possible cyclotron parameter modifications excluding the effect of the nonlinear coupling resonance are considered. The experiment with deuteron acceleration carried out on AIC-144 confirmed the results of the numerical calculations. 3 refs.; 5 figs.

41366 (JINR–9-89-301) **The systems of internal beam deflection to the target in the isochronous cyclotron.** Borisov, O.N. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems); Dmitrievskij, V.P.; Kol'ga, V.V.; Trejbal, Z. Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems. 1989. 7p. (In Russian). Order Number DE90633986. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

The systems of internal beam deflection to the target for medical radioisotope production in the isochronous cyclotron are considered. In this case the bean intensity is limited only by the power dissipated in the target. The radial step of the orbit in the U-120M type isochronous cyclotron is increased from 0.6 mm to $\approx$ 1 cm on the target azimuth in the energy interval of 30-37 MeV. In this case the beam axial dimension increases approximately by a factor of 2. 4 refs.; 5 figs.

41367 (LBL–28931) **Single resonance theory with maps.** Forest, E. (Lawrence Berkeley Lab., CA (USA)); Irwin, J. Lawrence Berkeley Lab., CA (USA). Apr 1990. 10p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00098 ;AC03-76SF00515. (CONF-9004230–1: Workshop on non-linear problems in future particle accelerators, Capri (Italy), 19-25 Apr 1990). Order Number DE90013352. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

We describe how one can perform a single resonance calculation using the single resonance map and the co-moving map. Again we emphasize that all the concepts of this paper have been implemented for the most complicated situations using the Differential Algebra Package of Berz. In theory, it is possible and desirable to do similar calculations on fitted maps (a la Warnock) with fitted canonical transformations, unfortunately the tools based on fitted maps are not yet as versatile as DA-based tools. 5 refs.

41368 (SLAC-PUB–5220) **Mutual compensation of wakefield and chromatic effects of intense linac bunches.** Seeman, J.T.; Merminga, N. Stanford Linear Accelerator Center, Menlo Park, CA (USA). May 1990. 10p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00515. (CONF-9009200–1: 1990 LINAC conference, Albuquerque, NM (USA), 10-14 Sep 1990). Order Number DE90013569. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

Mutual compensation of transverse and chromatic effects for intense electron bunches in a high-energy linac is a recent Novosibirsk idea which provides a new control of emittance enlargement. In this paper we elaborate on the principles and constraints for this new technique which requires careful matching of internal bunch parameters with external forces. With species values of the bunch length, bunch intensity, and klystron phasing, the transverse-wakefield-induced forces within the bunch can be cancelled by energy-dependent forces from the quadrupole lattice at all positions along the linac. Under these conditions the tolerances for quadrupole alignment, dipole stability, and injection launch errors are significantly relaxed. 7 refs., 8 figs.

41369 (SSC–6) **Simple method to symplectify matrices.** Furman, M. Lawrence Berkeley Lab., CA (USA). SSC Central Design Group. [1990]. 5p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-89ER40486. Order Number DE90014004. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

For matrices which are "approximately symplectic," in a sense defined below, we present a simple algorithm to render them symplectic. The algorithm is a rapidly convergent procedure which only involves a few matrix multiplies.

41370 (SSC–7) **Magnetic errors in the SSC: Preliminary report of the magnetic-errors working group of the SSC aperture workshop.** Peterson, J.M. (Lawrence Berkeley Lab., CA (USA). SSC Central Design Group); Fisk, H.E.; Gilbert, W.S.; Green, M.A.; Hassenzahl, W.V.; Meuser, R.B.; Scanlon, R.; Taylor, C.E.; Wenzel, W.A.; Pissanetsky, S. Lawrence Berkeley Lab., CA (USA). SSC Central Design Group. Apr 1985. 142p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-89ER40486. Order

Number DE90014115. Available from NTIS, PC A07/MF A01; OSTI; INIS; GPO Dep.

The four magnet types discussed in this report are briefly described in Section 1 of this report. However, for most purposes a discussion of random construction errors needs to deal with only two classes of magnets: collared cosine-theta and superferric. They are discussed in Section 2 and Section 3, respectively. Magnetization effects in the cosine-theta magnets are treated in Section 4. 42 refs., 40 figs., 31 tabs.

41371 (SSC–8) **Interpolation of off-energy matrices: Symplectic and otherwise (A comparison of methods).** Douglas, D. Superconducting Super Collider Lab., Dallas, TX (USA). 29 Jan 1985. 43p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-89ER40486. Order Number DE90014003. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

Several tracking programs simulate the motion of off-momentum particles by using transport matrices adjusted to compensate for the variation of the particle rigidity relative to the rigidity of a design particle. The off-momentum matrices are generally determined by one of two methods. First, the matrices may be re-evaluated for exactly the current momentum of the particle. This method is exact and symplectic: no approximations are involved. Alternatively, the matrices are computed for a "mesh" of momentum values; matrices at intermediate values are then obtained by interpolation on momentum. In this note we examine the interpolation procedure used in PATRICIA and show that it does not in general yield a symplectic matrix. We present two alternative interpolation schemes, suggested by Dragt and Leemann, which will yield a symplectic approximate to the exact off-momentum transport matrix. An alternative to symplectic interpolation, that of resymplectification of a nonsymplectic approximate is discussed by Furman in another SSC Technical Memorandum. We conclude with a brief computational comparison of a symplectic and the nonsymplectic interpolation schemes to the "benchmark" of calculating the exact off-energy matrix. We find that the interpolation scheme employed by PATRICIA is only marginally adequate for SSC studies but that a more accurate nonsymplectic interpolation may be sufficiently precise to provide a matrix which is symplectic to within the numerical precision of a computer. Also, we find that the symplectic interpolation algorithm considered does produce the advertised exactly symplectic matrix.

41372 (SSC–9) **Options to make PATRICIA symplectic.** Douglas, D. Lawrence Berkeley Lab., CA (USA). SSC Central Design Group. 14 Feb 1985. 5p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-89ER40486. Order Number DE90013997. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

Various options to "symplectify" the off-momentum linear transformations used in PATRICIA are presented. Strengths and weaknesses of each method are discussed. Numerical results from each method are outlined, and a recommendation for a 7-point Lagrange interpolation with single pass resymplectification is made.

41373 (SSC–14) **Overlap knock-out resonances in the SSC [Superconducting Super Collider].** Myers, S. Lawrence Berkeley Lab., CA (USA). SSC Central Design Group. Mar 1985. 6p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-89ER40486. Order Number DE90014106. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

The appearance of 'overlap-knock-out resonances' was first observed in the ISR. These resonances caused severe enlargement of the vertical beam dimensions and a significant reduction in the luminosity. Somewhat later these resonances were also observed with bunched beams of different energies in each ring, and under resonant conditions reduced the beam lifetime to a few seconds with a beam-beam tune shift of less than 10^{-5}. For the case of the SSC where the energies of the beams may under certain circumstances be unequal, these resonances may appear and cause beam loss.

41374 (SSC–16) **More on the overlap knockout resonances in the Superconducting Super Collider (SSC).** Chao, A.; Leemann, C.W. Lawrence Berkeley Lab., CA (USA). SSC Central Design Group. Apr 1985. 7p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-89ER40486. Order Number DE90014107. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

Steve Myers has pointed out that the overlap knockout resonances are potentially harmful to the stability of two beams with different revolution periods. In this note we present a follow-up study of this effect for the SSC. One possible reason for the two beams to have different revolution periods is operation at different energies, especially at injection. The velocity difference then translates into a difference in revolution periods. Another case is when the two beams have different horizontal orbit distortions (even when they have the same energy), which in turn makes the circumferences different. A third possible cause is when there is a circumference difference due to survey errors during construction. These effects can in principle be compensated by adjusting the rf frequencies, but this is done at the cost of aperture and ought to be avoided if possible.

41375 (SSC–20) **A possible screening procedure for random multipole field errors before tracking studies.** Peggs, S.; Furman, M.; Chao, A. Lawrence Berkeley Lab., CA (USA). SSC Central Design Group. 20 Apr 1985. 7p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-89ER40486. Order Number DE90014110. Available from NTIS, PC A02/MF A01; OSTI; INIS.

It is an elaborate process to evaluate the stability limit of particle motion in the presence of multipole field errors. Extensive analysis on the linear and nonlinear lattices and tracking studies are often required. It is therefore very useful to design "screening" procedures to tell if a particular set of multipole errors is unacceptable without extensive studies. Although passing the screening does not necessarily mean good stability limits, failing the screening does mean the stability region is too small to be acceptable. In this note we propose one possible screening procedure to be applied to the random multipole field errors in the SSC. Other screening procedures are not excluded from being applied simultaneously.

41376 (SSC–21) **Random sextupoles in the SSC [Superconducting Super Collider] lattice.** Heifets, S. (Texas Accelerator Center, The Woodlands, TX (USA)). Lawrence Berkeley Lab., CA (USA). SSC Central Design Group; Texas Accelerator Center, The Woodlands, TX (USA); Houston Univ., TX (USA). Apr 1985. 17p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-89ER40486. Order Number DE90014089. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

Distortion has been calculated as a function of rms of random sextupoles in regular cells for a typical SSC-kind lattice. The lattice was submitted under TAC14060, to the LBL data base. In the lattice with superperiodicity 6 there are two straight sections and an arc per period. Each straight section contains a low-beta triplet, a matching section, a trombone and a dispersion killer.

41377 (SSC–22) **Aperture task force interim report—Aperture criterion group.** Edwards, D. Lawrence Berkeley Lab., CA (USA). SSC Central Design Group. 22 Apr 1985. 4p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-89ER40486. Order Number DE90014105. Available from NTIS, PC A02/MF A01; OSTI; INIS.

the purpose of this interim report is to present a short, and, it is to be hoped, intelligible magnet aperture/field quality criterion. The first part is on the conceptual as opposed to the numerical content of the criterion. In the second part, we comment on the values that may be assigned to the various "blanks" in the criterion. The two-part division is made to indicate the distinction between the main issues. Does the criterion reflect an appropriate distillation of the host of accelerator physics considerations that are related to aperture and field quality? Do the numerical values suggested in the second part represent reasonable starting values for a costing cycle? The decision that this aperture/field criterion is supposed to assist relates to the magnets in the long bending arcs. The dynamical questions that are of immediate concern center around the tolerable multipole content of the main superconducting magnets. The criterion has been formulated in this context.

41378 (SSC–23) **Ion stability in bunched electron beams.** Douglas, D. Lawrence Berkeley Lab., CA (USA). SSC Central Design Group. [1990]. 2p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-89ER40486. Order Number DE90014087. Available from NTIS, PC A02/MF A01; OSTI; INIS.

Accumulation of ions can adversely affect the performance of an electron storage ring. Stability of ion motion under the influence of passing bunches is often used to predict if ion accumulation will occur in a particular storage ring design. This stability question has been previously studied with a linear model. We present a nonlinear numerical tool to study ion motion in a beam of short bi-gaussian electron bunches. Results of ion trapping studies on a model electron storage ring are presented. We find that including nonlinear effects may not significantly alter the conclusions of the linear model, and that in a ring containing many bunches a gap in the bunch train effectively destabilizes ion motion.

41379 (SSC–24) **Tracking the SSC test lattices.** Leemann, B.T.; Douglas, D.R.; Forest, E. Lawrence Berkeley Lab., CA (USA). SSC Central Design Group. [1990]. 4p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-89ER40486. Order Number DE90014104. Available from NTIS, PC A02/MF A01; OSTI; INIS.

The dynamic aperture and its determination emerged from the SSC reference design study as the single most important accelerator physics issue pertinent to the SSC. Beside the fundamental need of a finite dynamic aperture for any accelerator, it was considered to be a useful criterion for the magnet selection. An aperture workshop organized in November 1984 at LBL served the purpose to identify the various aspects of the aperture question and to organize the aperture task force accordingly. It was recognized that numerical models had to play an important role and the qualifications of several tracking codes were investigated. None of the existing codes could meet all of the criteria for an ideal tracking code and substantial program development became unavoidable. It was therefore decided to begin tracking SSC test lattices, which were provided by the aperture task force's lattice group and are described in an other paper to this conference, with existing tracking programs. 6 refs., 5 figs., 2 tabs.

41380 (SSC–25) **Collective effects and the design of the SSC [Superconducting Super Collider].** Bisognano, J.J. Lawrence Berkeley Lab., CA (USA). SSC Central Design Group. [1990]. 4p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-89ER40486. Order Number DE90013998. Available from NTIS, PC A02/MF A01; OSTI; INIS.

Evaluation of possible designs for the Superconducting Supercollider requires consideration of a variety of collective phenomena. Of particular interest is the scaling of current thresholds and growth rates with such parameters as machine circumference and aperture, magnetic field strength, momentum spread and acceptance, cell length, and phase advance. In this paper the interplay of collective effects and machine design is discussed with special attention to those issues which may by helpful in choosing a particular design. 11 refs., 2 tabs.

41381 (SSC–26) **On choosing an aperture.** Collins, T.L. (Fermi National Accelerator Lab., Batavia, IL (USA)). Lawrence Berkeley Lab., CA (USA). SSC Central Design Group; Fermi National Accelerator Lab., Batavia, IL (USA). Apr 1985. 9p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-89ER40486 ;AC02-76CH03000. Order Number DE90014092. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

The most difficult part of choosing an aperture is choosing the right method of choosing, after that the choice simply requires work. We must find just which important of a good ring, of the type we are designing, makes the severest demand on field quality and hence specifies the largest aperture. For electron rings, beam loss at many sigma makes the greatest demand because of the total dominance of synchrotron radiation. Proton rings and particularly superconducting proton rings are not similar to electron rings. The Fermilab experience with the Doubler and with the Main Ring shows very clearly that "workability" is the dominant virtue. An aperture decision based solely on beam loss from a modest beam size will not produce a good superconducting proton ring; a decision based on workability will. Workability is the property that the Main Ring lacks. The Doubler on the other hand has excellent workability, in spite of the more complex operation necessary for superconducting rings — for example correction elements must ramp to full field and generally will require different relative settings for injection, acceleration, and flat-top. Our problem is to express this quality concept in a numeric form.

41382 (SSC–28) **Effect of long range beam-beam interaction on the stability of coherent dipole motion.** Furman, M.A.; Chao, A.W. Lawrence Berkeley Lab., CA (USA). SSC Central Design Group. [1990]. 4p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-89ER40486. Order Number DE90014085. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

The coherent effect of beam-beam forces on the stability of the motion of beams as rigid bunches in a collider is studied by means of simulation. The number of bunches per beam is taken to be large, with many bunches colliding simultaneously within each interaction region. It is also assumed that they populate the beams uniformly, and that they are equally spaced. The interaction regions are all identical and evenly spaced. The collision forces are assumed to be one-dimensional linear kicks. Results for stability limits are presented, as a function of tune, for various beam configurations and several values of the crossing angle. 11 refs., 3 figs.

41383 (SSC–30) **Equivalence of Michelotti's normal form and the map normal form as used by the Marylie code.** Forest, E. Lawrence Berkeley Lab., CA (USA). SSC Central Design Group. Apr 1985. 12p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-89ER40486. Order Number DE90014083. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

The purpose of this paper is to establish the connection between Michelotti's normal form and our approach. We will show that they are equivalent. Our demonstration will be carried only to order ϵ in the perturbation. to carry it further is just a matter of "bookkeeping" and is not so essential. First of all we start with Hamilton's equations in Floquet variables as Michelotti does. 2 refs.

41384 (SSC–32) **Algebraic theory of beam-beam interaction in the thin lens model.** Forest, E.; Furman, M. Lawrence Berkeley Lab., CA (USA). SSC Central Design Group. Aug 1985. 40p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-89ER40486. Order Number DE90014102. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

In this paper we will set up a general model for the study of beam-beam interactions. First, we described the ring as made of N generalized interaction points (or GIP). These GIP's could be single IP or clustered IP's. They are equally spaced. Then we assign to the i^{th} GIP two generalized bunches (or GB) $\{\vec{\phi}^{i}, \vec{\psi}^{i}\}$. These two GB are colliding at the center of the i^{th} GIP. The GB can contain many bunches. This allows for the study of long range effect as well as clustered IP's within the GP. Finally, we adopt the Eulerian point of the view of hydrodynamic. The label "i" in $\vec{\phi}^{i}$ or $\vec{\psi}^{i}$ denotes the GB's at the i^{th} GIP. If $\vec{\phi}^{i}$ moves toward the right and $\vec{\psi}^{i}$ toward the left, we see that one collision later $\vec{\phi}^{i}$ is made of bunches previously at the $(i-l)^{th}$ GIP while $\vec{\psi}^{i}$ originates from the $(i+l)^{th}$ GIP.

41385 (SSC–38) **Analytic relation between errors and stability.** Wilson, E.J.N. Superconducting Super Collider Lab., Dallas, TX (USA). 8 Apr 1985. 12p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-89ER40486. Order Number DE90014042. Available from NTIS, PC A03/MF A01; OSTI; INIS.

Recent work at the SPS on the beam-beam effect shows how the analytic calculation of such stochastic limits give diffusion rates which agree with experimental results with the beam tuned to avoid high order resonances and when the beam is tuned onto these resonances. The results agree with simulation and show that the inclusion of synchrotron motion is essential if simulation is to reveal the true limits to stability. Experiments with the Antiproton Accumulator, where particles see a potential identical in form to the beam-beam effect from ions trapped in the beam, confirms the SPS experience and fits the analytic treatment. Tracking studies which do not include synchrotron motion seem only to reveal limits to stability due to an unwise choice of tune or to strong multipole content in the field which limits the dynamic aperture without synchrotron

motion and which would destroy the beam if the RF were switched on.Fortunately we do not have to wait for tracking programs fast and rigorous enough to follow particles over many synchrotron periods to make statements about acceptable tolerances. This paper shows how the methods of estimating stochastic thresholds and growth rates for the beam-beam effect may equally be applied to the case of resonances excited by external field imperfections.

41386 (SSC–40) **Preliminary lattice proposal for polarized beam acceleration in SSC.** Steffen, K. (Deutsches Elektronen-Synchrotron (DESY), Hamburg (Germany, F.R.)). Lawrence Berkeley Lab., CA (USA). SSC Central Design Group. Jun 1985. 12p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-89ER40486. Order Number DE90014098. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

This paper describes the use of Siberian snake lattice to accelerate polarized beams in the superconducting super collider. (LSP)

41387 (SSC–41) **Resonances in accelerators.** Talman, R. Lawrence Berkeley Lab., CA (USA). SSC Central Design Group. Jun 1986. 28p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-89ER40486. Order Number DE90014101. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

Various resonances important in accelerators are analyzed, with the intention of demonstrating their essential similarity. Transverse instabilities of bunched electron beams are emphasized, including beam-beam effects.

41388 (SSC–48) **Orbit correction in the long arcs of the Superconducting Super Collider (SSC).** Chao, A.W.; Peggs, S. Lawrence Berkeley Lab., CA (USA). SSC Central Design Group. Oct 1985. 21p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-89ER40486. Order Number DE90014009. Available from NTIS, PC A03/MF A01; OSTI; INIS.

In the SSC, it is envisioned that there will be a horizontal orbit corrector at each focussing quadrupole (QF), a vertical corrector at each defocussing quadrupole (QD) and a beam position monitor (BPM) at each QF and QD. For each plane, therefore, there are one corrector and two BPM's per cell. Since there are about 420 cells in the SSC, a straightforward orbit correction requires inverting an 420 × 420 matrix in which all elements are in general nonzero. This can be avoided by applying a beam bump technique. We will summarize the result of the beam-bump method. Section 3 of this paper gives our study results using this technique for the case of a long string of FODO cells. Section 4 applies these study results to estimate for the SSC the rms corrector strength needed for orbit correction, and the rms orbit distortion after correction. The orbit corrector strength suggested for the SSC is 10 times the rms value and agrees with a previous estimate.

41389 (SSC–51) **Treatment of the long range coherent beam-beam with the Vlasov equation.** Forest, E. Lawrence Berkeley Lab., CA (USA). SSC Central Design Group. Oct 1985. 19p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-89ER40486. Order Number DE90014011. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

In a previous SSC-report (SSC-32), we explained how one could get some analytical results in the study of dipole beam-beam collisions. We examined three cases. We solved exactly for the stability condition in the presence of head-on collisions (h.o.). Then we studied the change in these conditions as we add long-range collisions (l.r.). We obtained analytical results which agreed very well with the exact computer solution. The purpose of this paper is to extend to the l.r. collisions a calculation due to Chao and Ruth. This calculation reported in SLAC-PUB-3400/AP-37 (SLAC-37) used the Vlasov equation in the study of h.o. collisions. They looked at the effect of modes up to octupole order. In their formalism the ribbon beams are represented by two distribution functions Ψ and Φ.

41390 (SSC–52) **TEAPOT: A thin element accelerator program for optics and tracking.** Schachinger, L.; Talman, R. Lawrence Berkeley Lab., CA (USA). SSC Central Design Group. Dec 1985. 44p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-89ER40486. Order Number DE90014095. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

The program TEAPOT is described. It is intended for fast particle tracking in an accelerator with magnet errors and misalignments. A realistic lattice (Standard Input Format) is first mechanically translated into an acceptably similar lattice containing only thin elements. Tracking in that lattice is fast and exact. This procedure of exact tracking in an approximate lattice can be contrasted with approximate tracking in an "exact" lattice as is performed in existing programs. A full Twiss analysis is performed and there are provisions for the compensation of error-induced coupling, tune-shifts and chromaticity shifts.

41391 (SSC–57) **Computer simulation of satellite resonances caused by the beam-beam interaction at a crossing angle in the SSC [Superconducting Super Collider].** Piwinski, A. Lawrence Berkeley Lab., CA (USA). SSC Central Design Group. Jan 1986. 17p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-89ER40486. Order Number DE90013999. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

The beam-beam interaction at horizontal and vertical crossing angles in the SSC is simulated. It is shown that with the present SSC parameters several satellite resonances can be excited. The dependence on the working point, the crossing angle, the space charge parameter and the synchrotron frequency is investigated. 2 refs., 9 figs.

41392 (SSC–62) **Results of coherent dipole beam-beam interaction studies for SSC [Superconducting Super Collider] lattices.** Furman, M.A. Lawrence Berkeley Lab., CA (USA). SSC Central Design Group. May 1986. 21p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-89ER40486. Order Number DE90014444. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

Results are presented for the stability limit of the coherent beam-beam interaction as a function of tune for simplified lattice configurations. The results are obtained from a simulation program in which the beam-beam interaction is represented by one-dimensional linear kicks, and the bunches are considered to be rigid charged objects (dipole approximation). For nominal SSC parameters we find that the coherent beam-beam interaction introduces serious instabilities only in very narrow regions of tune around integers or half-integers (depending on the symmetry of the lattice considered), and therefore does not restrict the choice of tune significantly. 7 refs., 14 figs.

41393 (SSC–72) **Study of the aberrations of a periodic arc using the Lie algebraic techniques.** Forest, E.; Douglas, D.; Leemann, B. Lawrence Berkeley Lab., CA (USA). SSC Central Design Group. Jan 1986. 18p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-89ER40486. Order Number DE90014433. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The aberrations of a periodic achromat are analyzed using the map of a single periodic cell. An action-angle analysis of the Lie operators describing a cell is used to illustrate the differences amongst various phase advances per cell. 6 refs., 4 tabs.

41394 (SSC–75) **Magnet field quality requirements for the SSC [Superconducting Super Collider].** Chao, A.W. Lawrence Berkeley Lab., CA (USA). SSC Central Design Group. Jun 1986. 8p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-89ER40486. Order Number DE90014426. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

The question of magnet field quality can be asked in two ways. The direct way is to start with a magnet design, find out the field uniformity that is achieved by the design and then ask if the beam can take the achieved field uniformity. The question can also be asked in a reversed way. One then starts with the fact that the beam needs a "good field region" (GFR) for its stable operation. The GFR requirement translates into tolerances of field non-uniformity and one then asks if the magnets can make such tolerances. In this paper, we will address the reverse question and will use the SSC design, as presently conceived, as example.

41395 (SSC–80) **Simulation of synchrotron motion with rf noise.** Leemann, B.T.; Forest, E.; Chattopadhyay, S. Lawrence Berkeley Lab., CA (USA). SSC Central Design Group. Aug 1986. 6p. Sponsored by U.S. DOE Energy Research. DOE Contract

AC02-89ER40486. (CONF-860870–24: 13. international conference on high energy accelerators, Novosibirsk (USSR), 7-11 Aug 1986). Order Number DE90014656. Available from NTIS, PC A02/MF A01; OSTI; INIS.

We describe the theoretical formulation behind an algorithm for synchrotron phase-space tracking with rf noise and some preliminary simulation results of bunch diffusion under rf noise obtained by actual tracking. 8 refs., 7 figs.

41396 (SSC–86) **Energy loss of bunched beams in rf cavities.** Furman, M.; Lee, H.; Zotter, B. Lawrence Berkeley Lab., CA (USA). SSC Central Design Group. Aug 1986. 25p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-89ER40486. Order Number DE90014006. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

Bunched, charged particle beams lose energy when they traverse cavities or other structures which can be described by resonator impedances. The calculation of this loss is arbitrary quality factors by using known approximations for the sums of infinite series. For low Q-values, these expressions agree with those obtained by replacing the sums by integrals. The loss power in SSC is calculated using these expressions. 7 figs.

41397 (SSC–88) **Long-range tune shifts and other matters in high-β^* IRs.** Groom, D.E. Lawrence Berkeley Lab., CA (USA). SSC Central Design Group. 15 Sep 1986. 10p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-89ER40486. Order Number DE90014114. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

Two experimental configurations for the SSC are discussed in which B^* is likely to be quite large: Very low $p_\perp$ physics, especially for elastic scattering at less than 1 μrad. For the scattering angles to be large compared with the spread due to beam emittance, $B^* \gtrsim 4$ km. There is no ancillary requirement for a long free space, but just for warm sections of modest size at phase advance $\approx 90°$ away from the interaction point. For purposes of this Note, we take B^* =4000 m, and L as 85 m. High-rapidity physics, or, more accurately, physics which covers as much of the available rapidity region as possible. Because of the need to measure particles at angles between 0.2 mrad and 400 mrad, the interaction region (IR) free space needs to be $\pm$1000 m or even $\pm$2000 m long. While B^* as small as 50 m would be desirable, it is likely to be very large compared with the bunch spacing. To focus ideas, we take B^* = 500 m and L = 1000 m for the "bj IR." We also consider the case where the beams cross at an angle α and after a short distance (say 70 m) are brought parallel at a separation d for the remaining 930 m. Both of these configurations present problems not discussed in the Conceptual Design Report, which in most cases used approximations in which B^*/S_B was a small number. One could of course solved all problems connected with high-B^* IRs if the machine were run in a dedicated mode with $S_B \approx 4$ km, but we assume for purposes of this Note that such an option would fail to win a DPF plebiscite.

41398 (SSC–93) **Correction of persistent current effects on dynamic behavior of SSC lattices.** Leemann, B.T. Lawrence Berkeley Lab., CA (USA). SSC Central Design Group. Mar 1987. 15p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-89ER40486. Order Number DE90014007. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

The persistent current effects on the dynamic properties of a standard SSC test lattice with clustered IRs are shown for superconductor filaments of various diameters. Three different correction schemes are compared. The most complete compensation is achieved by locally correcting the b_2 and b_4 multipole components with two layers of bore tube corrector windings. Lumped correction by two independent two-family sextupole and decapole correctors proves insufficient. A nearly local correction scheme with the different corrector windings extending only over a fraction of the magnet length but arranged in a single layer is found to be an excellent compromise. 4 refs., 9 figs.

41399 (SSC–94) **Systematic study of the dependence of lattice dynamics on cell structure parameters.** Leemann, B.T.; Forest, E. Lawrence Berkeley Lab., CA (USA). SSC Central Design Group. Mar 1987. 10p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-89ER40486. Order Number DE90014099. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

The Conceptual Design Report (CDR) of the SSC foresees the following cell structure parameters: 60 deg. phase advance, 10 dipole magnets (l = 16.54 m), 4 cm coil diameter. In order to study systematically the dependence of the lattice dynamics on these 3 parameters, a large number of lattices based on cells with different cell structure parameters have been designed and their linear apertures determined, whereby the following ground rules had been followed: the lattice are built entirely from regular cells; in order to account for the chromaticity produced by the IRs, a corresponding number of cells with ideal dipole magnets are included; all lattices contain the same number of realistic (with random multipole errors) CDR dipole magnets. Linear aperture results obtained by tracking as well as from analytic calculations are tabulated and discussed. 5 refs., 4 figs.

41400 (SSC–95) **Analytical computation of the smear.** Forest, E. Lawrence Berkeley Lab., CA (USA). SSC Central Design Group. Oct 1986. 12p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-89ER40486. Order Number DE90014100. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

We explain an analytic computation of the map and the "smear" for a lattice composed of cells with random sextupole and octupole errors, as well as systematic chromatic sextupoles. Results are presented for the 60° and 90° lattices.

41401 (SSC–109) **CDR [Conceptual Design Report] lattice aperture limitations due to magnetic imperfections in the IR quadrupole triplets.** Leemann, B.T. Lawrence Berkeley Lab., CA (USA). SSC Central Design Group. Feb 1987. 21p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-89ER40486. Order Number DE90014040. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

The effect of magnetic imperfections in the arc dipole magnets on the linear and dynamic aperture of a variety of test-lattices has been explored in a number of particle tracking studies. These results have been incorporated in the conceptual Design Report and contributed to establish tolerances for the arc dipole magnet imperfections. Sorting and/or binning of the magnets according to a particular multipole moment proved most effective. The importance of the IR quadrupole imperfections to the dynamic aperture due to the large β - function values at their locations was first documented in tracking studies by Dell and Schachinger. In the present report we explore the dependence of the linear and dynamic apertures on lattice parameters such as the β - function value β^* and the crossing angle α at the interaction points in the low-β IRs for the nominal IR quad triplet multipole errors. Furthermore, the sensitivity of the dynamic aperture to the number of corrected multipole orders, to the residual multipole strengths and to the strengths of the higher, uncorrected multipole moments is examined. It should be understood, that the rms-values of the magnetic multipoles moments are implied, whenever we refer to "multipole errors". 10 refs., 11 figs., 1 tab.

41402 (SSC–111) **Hamiltonian-free perturbation theory: The concept of phase advance.** Forest, E. Lawrence Berkeley Lab., CA (USA). SSC Central Design Group. Feb 1987. 20p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-89ER40486. Order Number DE90014043. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

In this paper, we generalize the concept of phase advance to non- linear systems. We show how non-linear perturbation theory can be made in a totally Hamiltonian free context. As examples, we give expressions for the computation of first and second order tune shifts, as well as for the canonical transformation responsible for the first order distortions of the invariants. Our reliance on Lie operators allows for a very simple implementation of these methods in the context of an algebraic manipulator. 7 refs.

41403 (SSC–132) **Lumped correction of systematic multipoles in large synchrotrons.** Neuffer, D. (Los Alamos National Lab., NM (USA)). Lawrence Berkeley Lab., CA (USA). SSC Central Design Group. 15 Jun 1987: 25p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-89ER40486. Order Number

DE90014443. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

Uncorrected systematic multipole components of the dipoles in synchrotrons can cause unacceptably large amplitude and momentum dependent tune shifts. The problem is exacerbated by the relatively weak focusing (long focusing cells) in large synchrotrons and by the relatively high multipole content of high-field superconducting magnets. Correction of these tune shifts by lumped correction elements is described. A particularly effective method of correcting first-order tune shifts is a "three-lump" system with an additional correction element placed at the center of each half-cell as well as correctors at the ends of the half-cells near the F and D quads, with the relative strengths per half-cell of the correctors following Simpson's Rule for three-point integration. The method is compared with end corrector and distributed correction methods and its limitations in higher order sextupole correction are considered. Application to the Superconducting Super Collider (SSC) is discussed. 16 refs., 5 figs., 4 tabs.

41404 (SSC–144) **Iteration and accelerator dynamics.** Peggs, S. Lawrence Berkeley Lab., CA (USA). SSC Central Design Group. Oct 1987. 21p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-89ER40486. (CONF-8610108–8: 2. joint US/CERN school on particle accelerators: frontiers of particle beams, South Padre Island, TX (USA), 23-29 Oct 1986). Order Number DE90014459. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

Four examples of iteration in accelerator dynamics are studied in this paper. The first three show how iterations of the simplest maps reproduce most of the significant nonlinear behavior in real accelerators. Each of these examples can be easily reproduced by the reader, at the minimal cost of writing only 20 or 40 lines of code. The fourth example outlines a general way to iteratively solve nonlinear difference equations, analytically or numerically.

41405 (SSC–156) **An experimental study of the SSC [Superconducting Super Collider] magnet aperture criterion: A progress report on Fermilab experiment E778.** Chao, A. (Lawrence Berkeley Lab., CA (USA). SSC Central Design Group); Johnson, D.; Peggs, S.; Peterson, J.; Schachinger, L.; Meller, R.; Siemann, R.; Talman, R.; Vos, L.; Morton, P. Lawrence Berkeley Lab., CA (USA). SSC Central Design Group. 12 Jan 1988. 34p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-89ER40486. (FN–471). Order Number DE90013788. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

The magnetic field quality specification used in the SSC Conceptual Deign Report is based on the imposition of bounds to the departure from linear behavior in the oscillation of single particles about their closed orbits. The specification is physically reasonable, but it is important to give serious attention to the values assigned to the parameters in the criterion. This experiment is part of that effort. Nonlinearities in the magnetic fields will lead to gradual changes in the magnitudes of the transverse amplitude projections. The single point of the turn-by-turn plot will develop, in general, into an area. The distance of a point within this area to the mean position of all the points is a measure of the change of amplitude. The criterion places a limit on the ratio of this change to the mean amplitude. In particular, the rms value of this fractional excursion, termed the "smear,"is to be less than 7% within the aperture used for routine beam operations. The principles aims of experiment E778 are to determine if the smear is predictable from calculation, if the 7% bound is appropriate, and if modification of the criterion is necessary. The Tevatron was considered a suitable laboratory for this activity because it is a proton accelerator with excellent linear behavior; moreover there was a substantial number of sextupole magnets already installed that could be used as controllable sources of nonlinearity. This progress report is a summary of the effort on this experiment to date and preliminary analysis of the data.

41406 (SSC–172) **A novel method for correcting the SSC [Superconducting Super Collider] multipole problem.** Neuffer, D. (Lawrence Berkeley Lab., CA (USA). SSC Central Design Group). Lawrence Berkeley Lab., CA (USA). SSC Central Design Group. Apr 1988. 13p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-89ER40486. (SSC-N–525). Order Number DE90013789. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

A new method of correcting dynamic nonlinearities due to the multipole content of a large synchrotron such as the Superconducting Super Collider is discussed. The method uses lumped multipole elements placed at the center (C) of the accelerator half-cells as well as elements near the focusing (F) and defocusing (D) quadrupoles at the ends. In a first approximation, the corrector strengths follow Simpson's Rule. Correction of second-order sextupole nonlinearities may also be obtained with the F, C, and D octupoles. Correction of nonlinearities by $\sim$ three order of magnitude is obtained, and a solution to a fundamental problem in large synchrotrons is demonstrated. 13 refs., 2 figs., 2 tabs.

41407 (SSC–183) **Generalization of TEAPOT [Thin Element Accelerator Program for Optics and Tracking] to nonplanar lattices.** Sun, T.; Talman, R.; Paxson, V.; Schachinger, L. Lawrence Berkeley Lab., CA (USA). SSC Central Design Group. Aug 1988. 20p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-89ER40486. Order Number DE90014653. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

Formulas needed to convert the accelerator analysis program, TEAPOT, from planar to full three-dimensional geometry, are derived. This generalization is required for analyzing folded, "terrain-following," or any other nonplanar lattice. As in the original version the tracking is exact, and hence certainly symplectic. This report will form part of the TEAPOT manual. 2 refs., 4 figs.

41408 (SSC–230) **Calibration beams at the SSC [Superconducting Super Collider].** Autin, A. (Superconducting Super Collider Lab., Dallas, TX (USA)); Edwards, H.; Bensinger, J.R.; Baller, B.; Browning, F.; Coleman, R.; Cooper, J.; Cossairt, D.; Kula, L.; Malensek, A. Superconducting Super Collider Lab., Dallas, TX (USA); Fermi National Accelerator Lab., Batavia, IL (USA). 30 Apr 1989. 32p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-89ER40486 ;AC02-76ER03230. Order Number DE90013783. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

This paper discusses the following topics on the Superconducting Super Collider: beam specification at calibration halls; high energy booster options with tunnels to surface; switchyard; six beams with high and low power options; switchyard optics for both high and low energy transport; secondary beams; wide band beams; radiation shielding; tagging system; and test and calibration halls.

4303 Auxiliaries and Components

Refer also to citation(s) 41314, 41315, 41366, 41405, 41440, 41798, 42234

41409 (ANL–90/20) **Fixed mask assembly research for APS insertion devices.** Kuzay, T.M. Argonne National Lab., IL (USA). Jan 1990. 27p. Sponsored by U.S. DOE Energy Research. DOE Contract W-31109-ENG-38. Order Number DE90014739. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

The Fixed Mask Assembly (FMA) is the first component to interact with the photon beam. Two sets of a pair of FMA channels, vertically and horizontally disposed, contain the beam rather than define it. They are subject to very large heat fluxes during containment. In current practice, the FMA channels are made of heavy, seamless copper, have rectangular cross-sections, and are cooled internally with water. Channels are set at grazing angles ranging from 1 to 6 degrees with respect to the beam, depending on the type of insertion device. APS insertion devices will impose higher heat fluxes on FMAs. Therefore, a need exists to improve the FMA engineering, keeping in the mind the current design criteria and philosophy of FMAs. Preliminary analysis of current heat transfer practice indicates that the major resistance to heat transfer is on the coolant side. Therefore, FMA cooling would benefit from enhanced heat transfer on the coolant side. With this principle in mind, an experimental program has been undertaken to explore the feasibility of using high-performance copper tube configurations which are expected to yield heat transfer coefficients, "h," in single phase flow systems 2 to 5(?) times higher than equivalent plain

tubes. In this report, the experimental scope and a preliminary analysis of high-performance copper tube configurations are described.

41410 (BNL–44611) **Fast excitation wiggler development.** van Steenbergen, A.; Gallardo, J.; Romano, T.; Woodle, M. Brookhaven National Lab., Upton, NY (USA). May 1990. 13p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76CH00016. (CONF-9004232–1: 1. Angstrom FEL workshop, Sag Harbor, NY (USA), 22-27 Apr 1990). Order Number DE90013739. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

The design of an easily stackable, variable period length, fast excitation driven wiggler, making use of geometrically alternating substacks of Vanadium Permandur ferromagnetic laminations, interspaced with conductive, non magnetic, material laminations which act as eddy current induced "field reflectors," is discussed and experimental results obtained with short wiggler models are presented. 7 refs., 13 figs.

41411 (BNL–52211, pp. 184-190) **Application of switched-power techniques to quadrupoles.** Aronson, S.H. (Brookhaven National Lab., Upton, NY (USA)); Fernow, R.C. Brookhaven National Lab., Upton, NY (USA). 1988. (CONF-8810135–: Switched-power workshop, Shelter Island, NY (USA), 16-21 Oct 1988). In *Proceedings of the switched power workshop*. Order Number DE90008712. Available from NTIS, PC A12/MF A01.

Electric fields on the order of 1 GV/m may be achievable with very short (few ps) pulses. A field of 0.3 GV/m is equivalent in deflecting strength to a magnetic field of 1 Tesla. We consider here the possibility of replacing magnets (specifically final focus quadrupoles) with laser-switched devices. 7 refs.

41412 (IAE–4816-2) **Secondary particle magnetic achromatic separator for the IAEh cyclotron.** Buranov, V.V. (and others); Venikov, N.I.; Dobychin, A.I. Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow (USSR). Inst. Atomnoj Ehnergii. 1989. 17p. (In Russian). Order Number DE90634003. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

A magnetic achromatic separator of exotic nuclei is designed for cyclotron experiments with recording particles emerging from the target at small angles (including that of 0 deg) as well as for separation and use of radioactive nuclei, such as ^{6}He, ^{8}He, ^{7}Be. The ion-optic system of the separator is a symmetric magnetic achromatic consisting of two dipole magnets with the homogeneous field and beveled edges, two doublets and one singlet of quadrupole magnets. The separator characteristics, design and possible applications are presented. 15 refs.; 12 figs.

41413 (IFVE-OKU–88-112) **Excitation of corrugated vacuum chamber with proton beam.** Pashkov, P.T. Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Serpukhov (USSR). Inst. Fiziki Vysokikh Ehnergij. 1988. 16p. (In Russian). Order Number DE90633998. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

A formula for the longitudinal impedance of the proton synchrotron vacuum chamber composed of short corrugated sections separated with the smooth insertions has been obtained. The impedance is shown to involve a superposition of some quite narrow resonances when the corrugated sections are placed periodically. As an example the longitudinal impedance of the IHEP accelerator vacuum chamber has been calculated. The result obtained is responsible for the complex structure of the microwave radiation spectra from the accelerator experiments. 7 refs.; 4 figs.

41414 (IFVE-OUNK–89-159) **Transverse impedance of a corrugated vacuum chamber.** Balbekov, V.I.; Pozdeev, M.Yu. Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Serpukhov (USSR). Inst. Fiziki Vysokikh Ehnergij. 1989. 10p. (In Russian). Order Number DE90634000. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

The transverse impedance of the corrugated vacuum chamber of the IHEP proton accelerator U-70 is calculated using conformal mapping. The characteristics of the resonance at $\approx$ 6 GHz frequency are studied. The effect of the chamber non-uniformities is statistically taken into account. The transverse beam instability region at high frequencies is evaluated in the U-70. 6 refs.; 3 figs.

41415 (IFVE-OUNK-OEA–89-85) **Developing the equipment for compound impregnation and insulator winding on superconducting transposed cables for UNK dipoles.** Oshchepkov, V.P. (and others); Popov, V.V.; Surkov, A.N. Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Serpukhov (USSR). Inst. Fiziki Vysokikh Ehnergij. 1989. 10p. (In Russian). Order Number DE90633999. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

The equipment for preparation and insulator winding for superconducting cable of the UNK dipoles is described. The unit for the impragnation provides homogeneity with ± from the compound weight in the insulator. A possibility to vary the contents of the compound in the insulator can be reali zed by changing the speed ratio between the fiberglass insulator and the plunger of the dozing unit. This can be done smoothly w ith the automatic control system. The insulating machine consist s of two winding units with automatic digital control systems. The pitch of the laps can be smoothly changed within the range (2-20)±0.1 mm from the control board. 3 refs.; 5 figs.; 2 tabs.

41416 (IYaF–89-64) **Two-gap resonator of circular scanning with HF regeneration.** Arbuzov, V.S.; Gorniker, Eh.I.; Shekhtman, I.A. AN SSSR, Novosibirsk (USSR). Inst. Yadernoj Fiziki. 1989. 11p. (In Russian). Order Number DE90634001. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The layout of a resonator for circular SHF scanning of relativistic particle beam where a part of deflected beam power is taken to excite the resonator is described. Two strongly coupled cavities are tuned by the same automatic fine tuning -system unlike the systems with separate resonators. 3 refs.; 5 figs.

41417 (JINR–9-89-199) **About criteria of vibrodiagnostics of phasotron frequency variator.** Bogach, V.A.; Vasilenko, A.T.; Onishchenko, L.M. Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems. 1989. 10p. (In Russian). Order Number DE90633993. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

A system of vibrocontrol and vibrodiagnostics of frequency variator of JINR phasotron is described. It is intended for controlling the state of ball bearing on which two coaxially positioned 1530 kg rotors rotate in vacuum with up to 3000 rotation/min. 10 refs.; 10 figs.

41418 (JINR–9-89-388) **Forming and transport of the dense electron beam in a solenoid field.** Viktorov, Yu.B.; Kaminskij, A.K.; Kosukhin, V.V.; Sarantsev, V.P.; Sergeev, A.P. Joint Inst. for Nuclear Research, Dubna (USSR). 1989. 8p. (In Russian). Order Number DE90633997. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

The results of the experiment on the transport and forming of the dense electron beam with small oscillations of the current density of 1 kA/cm^2 in th longitudinal magnetic field on the system length are given. The peculiarity of the experiment consists of the fact, that the electron source is the LIU-3000 accelerator with a relatively small current pulse of 200 A. The monitoring system and the system of the electron beam coherent angle correction are examined. 4 refs.; 6 figs.

41419 (JINR-E–2-89-214) **High-current cyclotron injector.** Vorozhtsov, S.B.; Glazov, A.A.; Dmitrievskij, V.P.; Zaplatin, N.L.; Kalinichenko, V.V.; Onishchenko, L.M. Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions. 1989. 12p. Order Number DE90633996. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Choosing the parameters of a high-current cyclotron intended for production of 1-10 mA intensity beam is considered. The cyclotron is assumed to be used as an injector for deuteron accelerating facility to 45 MeV/nucleon energy. 13 refs.; 4 figs.; 1 tab.

41420 (JINR-R–9-89-355) **On a problem of modification of the induction linac (LIA-30) accelerating system.** Shvets, V.A. Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Neutron Physics. 1989. 7p. (In Russian). Order Number DE90633992. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

Problems connected with the modification of the LIA-30 accelerating system intended for 30 MeV electron energy have been considered. Pulse, induction and focusing systems are subjects to

improvement. In the pulse system the second channel is developed and assembled on the positive polarity of the output pulse owing to the use of the reserve thyratron modulator. The connection of inductors exciting coils in the induction system was used according to the scheme with an alternating polarity under the condition of the ground body of the section and unipolar demagnetization. In the focusing system a focusing solenoidal type element performed with a hollow copper flat wire in two rows with water cooling is set in the special body of each inductor. The increase of the design accelerating voltage on the section in 1.7 times is obtained. The focusing element at 1 kA current, 250 mks pulse duration, 900 V voltage and 60 μH selfinductance enables to get the field in the centre on the axis of 3 kOe. 2 refs.; 2 figs.

41421 (KEK–89-12, pp. 46-50) **Resonant electron beam extraction from TRISTAN-AR.** Endo, Kuninori (National Lab. for High Energy Physics, Tsukuba, Ibaraki (Japan)). National Lab. for High Energy Physics, Tsukuba, Ibaraki (Japan). Sep 1989. (CONF-8810498–: Workshop on the experiments by polarized proton and electron beams, Tsukuba (Japan), 27-28 Oct 1988). In *Proceedings of the workshop on the experiments by polarized proton and electron beams.* Order Number DE90777829. Available from NTIS (US Sales Only), PC A11/MF A01.

Extracting electrons from an electron synchrotron is possible by several methods, if the efficiency and spill structure are not asked. Scattering electrons using an internal targets and shaving circulating electron bunches with a thin septum by pushing them outwards will give a big disturbance to the extracted beam. Scattering extraction is one of the easier methods, however, its extraction efficiency will be limited because electron trajectories depend on the scattered angle by the target. Whereas in the case of the shaving method, high efficiency can be expected but the spill structure is difficult to control. Most promising method at present will be the slow extraction from view points of efficiency and spill structure. So the most part of this manuscript treats the possibility of slow electron beam extraction from the TRISTAN-AR synchrotron. The electron accumulation ring, TRISTAN-Ar, has been constructed for the booster injector to the TRISTAN main ring (MR) and now serves to the special programs such as the synchrotron light and e^+-e^- colliding experiments as well. Either of these programs is carried out every time after filling the main ring with both electron and positron beams. There are no special considerations in the lattice structure itself other than the injector, colliding experiment and synchrotron light source. Now these programs have been sharing the experiment time and also the device space. Therefore, many restrictions shall be overcome to obtain the slow extracted electron beam. (author).

41422 (LBL–28913) **High magnetic field multipoles generated by superconductor magnetization within a set of nested superconducting correction coils.** Green, M.A. Lawrence Berkeley Lab., CA (USA). Apr 1990. 5p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00098. (CONF-900423–1: 13. international cryogenic engineering conference (ICEC-13), Beijing (China), 24-27 Apr 1990). Order Number DE90014187. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

Correction elements in colliding beam accelerators such as the SSC can be the source of undesirable higher magnetic field multipoles due to magnetization of the superconductor within the corrector. Quadrupole and sextupole correctors located within the main dipole will produce sextupole and decapole due to magnetization of the superconductor within the correction coils. Lumped nested correction coils can produce a large number of skew and normal magnetization multipoles which may have an adverse effect on a stored beam at injection into a high energy colliding beam machine such as the SSC. 6 refs., 2 figs., 2 tabs.

41423 (NAC–88-17) **Calibration of Farmer dosimeter and Geiger-Mueller counters.** Yudelev, M. (Faure Hospital (South Africa)); Jones, D.T.L. National Accelerator Centre, Faure (South Africa). Nov 1988. 8p. Available from the National Accelerator Centre, Council for Scientific and Industrial Research, P.O. Box 72, Faure, 7131, South Africa.

According to the protocol adopted at NAC for neutron beam calibration a Farmer type dosimeter is the Secondary Standard instrument used to obtain the exposure calibration factors for tissue equivalent (TE) ion chambers in Co-60 beam. Miniature Geiger-Mueller (GM) counters are used in conjunction with the TE ion chambers to determine the gamma dose component in mixed neutron-gamma radiation fields which are produced by the neutron therapy treatment system. The calibration factors for the GM counters are somewhat lower (≈10%) than previous measurements with similar counters. The orientational changes in the sensitivity of the GM counters cause a change of about 14% in the calibration factor of Far West Technology (GM2) counter and about 2% for Alrad (ZP1300) counters either with or without the Li^6F caps. The attenuation of the Co-60 gamma rays in the Li^6F cap results in an increase of the calibration factor by about 2% for all counters. 2 figs., 5 refs., 4 tabs.

41424 (SLAC-PUB–5217) **High-resolution simulation of field emission.** Herrmannsfeldt, W.B. (Stanford Linear Accelerator Center, Menlo Park, CA (USA)); Becker, R.; Brodie, I.; Rosengreen, A.; Spindt, C.A. Stanford Linear Accelerator Center, Menlo Park, CA (USA). Mar 1990. 14p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00515. (CONF-9004211–2: 3. international conference on charged particle optics, Toulouse (France), 24-27 Apr 1990). Order Number DE90013640. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

High-resolution simulations of field emission electron sources have been made using the electron optics program EGN2. Electron emission distributions are made using the Fowler-Nordheim equation. Mesh resolution in the range of 1-5 Å is required to adequately model surface details that can result in emission currents in the range found experimentally. A typical problem starts with mechanical details with dimensions of about 1μ. To achieve high resolution a new boundary is defined by the tip, a nearby equipotential line, and a pair of field lines. The field lines (one of which is normally the axis of symmetry) define Neumann boundaries. This new boundary is then used by the boundary preprocessor POLYGON to create an enlarged version of the problem, typically by a factor of ten. This process can be repeated until adequate resolution is obtained to simulate surface details, such as microprotusion, that could sufficiently enhance the surface electric fields and cause field emission. When simulating experimental conditions under which emission of several microamperes per tip were observed, it was found that both a locally reduced work function and a surface protrusion were needed to duplicate the experimental results. If only a local region of reduced work function is used, the area involved and the extent of the reduction both need to be very large to reproduce the emission. If only a surface protrusion is used, it is possible to get the observed emission current with a reasonable protrusion of length a few times radius, but then the resulting beam spreads over a very large solid angle due to the strong local radial electric fields. 8 refs., 14 figs., 1 tab.

41425 (SLAC-PUB–5257) **High current density pulsed cathode experiments at SLAC.** Koontz, R.; Fant, K.; Vlieks, A. Stanford Linear Accelerator Center, Menlo Park, CA (USA). Jun 1990. 5p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00515. (CONF-9006242–1: Workshop on short pulse high current cathodes, Bendor (France), 18-22 Jun 1990). Order Number DE90013639. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

A 1.9 microperveance beam diode has been constructed to test high current density cathodes for use in klystrons. Several standard and specially coated dispenser cathodes are being tested. Results of tests to date show average cathode current densities in excess of 25 amps/cm, and maximum electric field gradients of more than 450 kV/cm for pulses of the order of 1μsec. 3 refs., 11 figs.

41426 (SSC–11) **SSC Aperture Task Force review.** Lawrence Berkeley Lab., CA (USA). SSC Central Design Group. 19 Feb 1985. 21p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-89ER40486. Order Number DE90014096. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

The aperture evaluation for the several proposed SSC magnet styles has been identified as the most urgent accelerator-physics task, first during the SSC reference designs studies and then again during the November Aperture Workshop. After the November workshop, an SSC Aperture Task Force (ATF) was formed to carry out the tasks identified in the November workshop. A review of the

task force status was made in December 1984. As suggested in the December meeting, the ATF held a second review meeting on 2/19/85 at FNAL, which is the subject of this report.

41427 (SSC–76) **Design of the 4.35 K cryogenic system for SSC.** McAshan, M.S. Lawrence Berkeley Lab., CA (USA). SSC Central Design Group. Jun 1986. 6p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-89ER40486. (CONF-860583–8: International Committee for Future Accelerators workshop on superconducting magnets and cryogenics, Upton, NY (USA), 12-16 May 1986). Order Number DE90014655. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

The cryogenic system for the conceptual design of the SSC is described. The collider consists of two rings of superconducting magnets some 85 km in circumference. The principal design issues of the SSC cryogenic system are the production of the refrigeration needed for the operational loads, the transport of the refrigeration to all parts of the system, the provision for redundancy and reparability leading to high availability of the system, and the provision for non-steady state operation such as cool-down and quench recovery in a way that provides a suitable operating schedule for the whole facility. 5 refs., 2 figs., 3 tabs.

41428 (SSC–102) **Status of the SSC photodesorption experiment.** Bintinger, D. (Lawrence Berkeley Lab., CA (USA). SSC Central Design Group); Limon, P.; Joestlein, H.; Trbojevic, D. Lawrence Berkeley Lab., CA (USA). SSC Central Design Group. Dec 1986. 17p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-89ER40486. Order Number DE90014044. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

The 20 TeV protons of the SSC will emit significant amounts of synchrotron light. This light will desorb gases from the cold beam tube walls of the SSC, giving rise to a density of gas molecules within the cold bore. To predict this density, data have been taken on photodesorption from cold (4.5 K) beam tubes at the VUV electron storage ring at the National Synchrotron Light Source. 8 figs., 3 tabs.

41429 (SSC–107) **Tune shifts and compensation from systematic field components.** Jackson, A. Lawrence Berkeley Lab., CA (USA). SSC Central Design Group. Feb 1987. 16p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-89ER40486. Order Number DE90014039. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

This paper describes a formalism to calculate the betatron tune shifts arising from localized higher order multipole components. The results are used to find the tune shifts from the systematic components in the SSC dipole magnets and to set upper limits on the amplitudes of these components. When compared with the expected amplitudes, we find that the components up to n = 6 (14-pole) are unacceptably large and necessitate some form of compensation. Correction with bore tube windings provides the most satisfactory solution, but is expensive. Therefore, we investigate correction by lumped elements contained in the spool pieces adjacent to the quadrupoles. 5 refs., 2 figs., 3 tabs.

41430 (SSC–112) **Response to operating conditions of the SSC [Superconducting Super Collider] magnet using nonlinear finite element analysis.** Karpenko, V.N.; Zaslawsky, M. Lawrence Berkeley Lab., CA (USA). SSC Central Design Group. Mar 1987. 4p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-89ER40486. (CONF-870302–259: Particle accelerator conference, Washington, DC (USA), 16-19 Mar 1987). Order Number DE90014111. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

Using a plane strain 2D finite element model to represent the dipole magnet, and material properties as a function of temperature, the operating conditions and environmental conditions were simulated to evaluate the adequacy of the design, investigate areas of nonconformance, evaluate modifications to the design, support analytically the measurement effort, and by performing a sensitivity analysis, determine what design parameters are critical. These objectives have been met by the current analysis. 6 refs., 6 figs.

41431 (SSC–126) **Non-linear finite element analysis of the SSC [Superconducting Super Collider] superconductivity magnet: Including the effects of cool down, operation, quench, pre-assembly loads, and Lorentz Forces.** Zaslawsky, M. Lawrence Berkeley Lab., CA (USA). SSC Central Design Group. Apr 1987. 135p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-89ER40486. Order Number DE90014038. Available from NTIS, PC A07/MF A01; OSTI; INIS; GPO Dep.

A two-dimensional plane strain model of the SSC magnet (cold mass) was developed to determine the stresses and deflections under a variety of conditions. Cool down from room temperature to 4.35 K and the effects of quench in the coils were calculated using the computer code TACO – a finite element heat transfer code. Pre-assembly loads, energization to 6.6 tesla, pressure due to liquid helium, Lorentz Forces on the copper plated beam tube, were incorporated in NIKE2D – 2-D vectorized implicit finite element code. The model for material behavior was treated as thermo-elastic plastic which required material properties as a function of temperature. The programs were run remotely on the Cray computers in Livermore via the Vax computers at Berkeley.

41432 (SSC–127) **A liquid nitrogen temperature SSC [Superconducting Super Collider].** McAshan, M.S.; VanderArend, P. Lawrence Berkeley Lab., CA (USA). SSC Central Design Group. Apr 1987. 14p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-89ER40486. Order Number DE90014008. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Under the assumption that new developments in the science of superconductivity will lead to dipole magnets suitable for the SSC that have the same properties with regard to field, field quality, size and cost as those in the present conception of the collider, but operating at 77 K rather than 4.35 K; the initial cost of the collider facility is found to be less by $213 M out of the $2,000 M actual construction cost for the collider technical systems and the conventional facilities estimated in the Conceptual Design Report. EDI and contingency is not included in these figures. Operation at the higher temperature is not, however, an unequivocal advantage. The beam line vacuum system in the 77 K case presents problems that will require a larger magnet aperture for satisfactory solution. The costs of this together with the cost of the development and construction of the new vacuum system required is estimated to be $156 M. The net capital cost saving associated with the higher temperature operation is thus found to be $57 M or about 3% of the estimated cost. In addition it is estimated that the operating cost of the facility will under conditions be less by $27.5 M per year in the steady-state including an allowance for the greater availability of the simpler cryogenic system. 14 refs., 1 fig., 4 tabs.

41433 (SSC–139) **Layout and performance of a high-luminosity insertion for the SSC.** Garren, A.A.; Johnson, D.E.; Scandale, W. Lawrence Berkeley Lab., CA (USA). SSC Central Design Group. Sep 1987. 7p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-89ER40486. Order Number DE90015096. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

An experimental insertion with the beta functions at the crossing point as low as a quarter of a meter has been designed for the SSC by using quadrupoles with 330 T/m gradients. A free space ±3 m around the interaction point is available to install an experimental device dedicated to the observation of large transverse momentum reactions. A phase advance of 90° across the overall insertion ensures to some extent the mutual compensation of the chromatic aberrations of the quadrupoles triplets with those of the next experimental region. 4 refs., 6 figs.

41434 (SSC–163) **Resonant impedance in a toroidal beam pipe.** Ng, King-Yuen (Lawrence Berkeley Lab., CA (USA). SSC Central Design Group). Lawrence Berkeley Lab., CA (USA). SSC Central Design Group. Feb 1988. 35p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-89ER40486. (FN–477). Order Number DE90013786. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

The electromagnetic fields generated by a beam inside a toroidal beam pipe are derived. Special attention has been given to the resonances developed. The effective impedance seen by the beam is computed and the effects of displacing the beam away the beam

pipe center are considered. Applications are made to the SSC and the TEVATRON.

41435 (SSC–180) **Minimum propagating zone of the SSC superconducting dipole cable.** Ng, King-Yuen (Lawrence Berkeley Lab., CA (USA). SSC Central Design Group). Lawrence Berkeley Lab., CA (USA). SSC Central Design Group. Aug 1988. 44p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-89ER40486. (FN–491). Order Number DE90013784. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

We have studied the time evolution of a concentrated disturbance in superconducting cables. If the initial energy of the disturbance is small, the disturbance temperature profile spreads out, approaches a critical temperature profile slowly, and subsides eventually. If the energy in the disturbance is big enough, the disturbance also spreads out until it reaches a critical profile. After that, however, the temperature rises everywhere resulting in a quench. In both cases, no nontrivial steady state has been reached. These results inspire us to study propagating solutions instead. They are heated zones whose temperature grows at all points along the cable. The propagating solution which contains the least energy is called the minimum propagating zone (MPZ). In Section 3, these propagating zones are approximated using the steady-state heat flow equation. We find that the energy in the approximate MPZ gives the correct order-of-magnitude estimate to the minimum energy required to cause a quench. In Section 2, we list and define all the input information required in the heat flow equation. The results of the computation are discussed. Finally, some remarks and conclusions are given.

41436 (SSC–195) **Lengthy disturbances and copper-to-superconductor ratio.** Ng, King-Yuen (Lawrence Berkeley Lab., CA (USA). SSC Central Design Group). Lawrence Berkeley Lab., CA (USA). SSC Central Design Group. Nov 1988. 11p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-89ER40486. (FN–501). Order Number DE90014650. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

In a superconducting cable strand, the superconductor is in the form of fine filaments embedded in a matrix of copper. A large amount of copper is definitely desired because it can conduct away the heat and carry the current in the event of a heat deposition, so that a quench can be prevented. However, a sufficient amount of superconductor is necessary to carry the high dipole current. A higher amount is desired so that the point of operation is far away from the thermodynamic surface that separate the superconducting phase from the normal phase. Unfortunately, there must be a trade off between the amount of superconductor and copper, because there is only limited volume in the superconducting dipole magnet to house the superconducting cable. As a result, the copper-to-superconductor ratio becomes a crucial parameter, which must be carefully chosen in order to optimize the stability of the cable. In previous paper, we study this ratio for a disturbance evolving from a point deposition of energy using the method of minimum propagating zone (MPZ). But disturbances may not originate from a point of infinitesimal size. For example, the energy released due to coil movements, coils rubbing each other, flux jumps, et cetera, can deposit heat on a finite length of cable like a few mm or longer. In this paper, we try to look at disturbances that are lengthy and see whether the optimized copper-to-superconductor ration will be altered.

41437 (SSC–223) **Oxide superconductors and the Superconducting Super Collider (SSC).** Dahl, P.F. Superconducting Super Collider Lab., Dallas, TX (USA). Aug 1989. 28p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-89ER40486. Order Number DE90013758. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

In the spring of 1987, a CDG task force was formed to study the potential impact that the new high-T_c oxide superconductors might have on the SSC. The charge to the task force was to investigate the cost and operational impact of introducing a conductor having a range of transition temperatures and upper critical fields well above those of today's niobiumtitanium. In carrying out its investigation, the task force frequently consulted with key individuals in this developing field, among them scientists from Bellcore, Westinghouse, Brookhaven National Laboratory's Materials Science Division, and the Applied Superconductivity Center at the University of Wisconsin. The task force issued preliminary reports addressing the cost of operating the collider at liquid nitrogen temperature and issues concerning operation at magnetic field levels well in excess of that currently specified for the SSC design. In addition, the task force members strove to stay well informed of both basic and applied superconductivity developments worldwide via the burgeoning technical literature. The present report summarizes the principal findings of the task force, no longer active, to address the paramount issues within the purview of its original charge in light of the tentative state of knowledge of oxide superconductivity then available, and to readdress the findings from the vantage of 1989.

41438 (SSCL–255) **Quench origins.** Devred, A. (National Lab. for High Energy Physics, Tsukuba, Ibaraki (Japan)). Superconducting Super Collider Lab., Dallas, TX (USA); National Lab. for High Energy Physics, Tsukuba, Ibaraki (Japan). Mar 1990. 47p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-89ER40486. (CONF-890786–2: US particle accelerator school, Upton, NY (USA), 24 Jul - 4 aug 1989). Order Number DE90013768. Available from NTIS, PC A03/MF A01; OSTI; INIS.

In this paper, I shall discuss the quench origins. I shall first establish a method of classification and introduce the notions of conductor-limited and energy-deposited quenches. Next the paper will be devoted to the study of conductor-limited quenches, and I shall introduce the notions of plateau and of fraction of short sample. Also the paper will be devoted to the study of energy-deposited quenches, and I shall introduce the notions of training and of minimum energy deposit; I shall then review the possible causes of energy release. Lastly, I shall introduce the notion of operating margin, and I shall indicate how to optimize the operating margin in order to limit the risk of premature quenching. 112 refs., 14 figs.

41439 **H^- and Li^- enhancement in a multicusp source.** Leung, K.N. (Lawrence Berkeley Lab., CA (USA). Accelerator and Fusion Research Div.); Walther, S.R.; Kunkel, W.B. pp. 584-591 of Microwave and particle beam sources and directed energy concepts: Volume 1061. Brandt, H.E. Society of Photo-Optical Instrumentation Engineers, Bellingham, WA (USA) (1989). DOE Contract AC03-76SF00098. (CONF-8901158–: Microwave and particle beam sources and directed energy concepts, Los Angeles, CA (USA), 16-18 Jan 1989).

H^- and Li^- have many useful applications in accelerator and fusion research. It has been demonstrated that these negative ions can be generated either by surface conversion or by volume processes. Since the H^- or Li^- ions produced by volume processes have lower transverse energy then those formed by surface conversion processes, the emittance of the H^- or Li^- beam extracted from volume sources will be much lower. Experimental investigations have been conducted to enhance the H^- and Li^- yield in the volume multicusp source by optimizing the source geometry and by mixing various elements with the background hydrogen or lithium. The largest improvement is achieved by adding cesium vapor to the source, resulting in a factor of sixteen increase in H^- output. Source operation with an admixture of lithium and cesium has also been tested for the production of Li^- ions.

4304 Storage Rings

41440 (CONF-900726–1) **Polarized gas targets for storage rings.** Holt, R.J. Argonne National Lab., IL (USA). [1990]. 16p. Sponsored by U.S. DOE Energy Research. DOE Contract W-31109-ENG-38. From International conference on polarization phenomena in nuclear physics; Paris (France); 9-13 Jul 1990. Order Number DE90013655. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

It is widely recognized that polarized gas targets in electron storage rings represent a new opportunity for precision nuclear physics studies. New developments in polarized target technology specific to internal applications will be discussed. In particular, polarized gas targets have been used in the VEPP-3 electron ring in Novosibirsk. A simple storage cell was used to increase the total target thickness by a factor of 15 over the simple gas jet target from an atomic beam source. Results from the initial phase of this project will be reported. In addition, the plans for increasing the luminosity

by an additional order or magnitude will be presented. The application of this work to polarized hydrogen and deuterium targets for the HERA ring will be noted. The influence of beam-induced depolarization, a phenomena encountered in short-pulse electron storage rings, will be discussed. Finally, the performance tests of laser-driven sources will be presented. 8 refs., 12 figs., 1 tab.

41441 (IC–89/409) **Prospects of the future ep and γp colliders: Luminosity and physics.** Sultanov, S.F. International Centre for Theoretical Physics, Trieste (Italy). Dec 1989. 22p. Order Number DE90634024. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The new type of ep colliders based on TeV energy e^+e^- linacs (VLEPP, CLIC, LSC) and large pp storage rings (UNK, LHC, SSC) is considered. This type of ep colliders is advantageous not only in $\sqrt{s}$ comparing with standard ep machines (HERA, LHC+LEP), but it also provides a unique possibility to construct γp colliders with practically the same $\sqrt{s}$ and luminosity. it is shown that within the reasonable optimization of proton beam parameters, the luminosity $L_{ep,\gamma p}=10^{30}$-$10^{31}cm^{-2}s^{-1}$ can be achieved for the UNK+VLEPP project. The potential of these machines in testing the standard model and probing new physics at distances $1 <$ or approx. 10^{-17}cm is briefly discussed. (author). 12 refs, 5 figs, 7 tabs.

41442 (IFVE-OUNK–89-108) **Calculation of a vacuum system of the UNK first stage with an irregular structure.** Maslennikov, I.L.; Mirzoev, K.G. Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Serpukhov (USSR). Inst. Fiziki Vysokikh Ehnergij. 1989. 9p. (In Russian). Order Number DE90634025. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

There has been considered a technique to calculate the parameters of extended vacuum systems with an irregular structure. The calculational results for the average pressure and critical coefficient of ion induced gas desorption for sectors of the 1st stage of UNK with different chamber cross-section and distance between pumps are given. 3 refs.; 2 tabs.

41443 (IFVE-OUNK–89-125) **Longitudinal instability of azimuthal-nonsymmetric beam in a synchrotron.** Balbekov, V.I.; Ivanov, S.V. Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Serpukhov (USSR). Inst. Fiziki Vysokikh Ehnergij. 1989. 16p. (In Russian). Order Number DE90634026. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Usually a theoretical study of longitudinal instability implies the concept of a closed beam of identical and equally spaced bunches. But this model is totally inadequate for the UNK particularly during the period of injection into its first stage. The paper presents an approach to the problem of longitudinal instabilities in this case. The features peculiar to beam oscillation eigenmodes are discussed. The computational results for the UNK are enclosed. 9 refs.; 2 figs.

41444 (IFVE-OUNK–89-164) **Transverse impedance of some elements of the UNK vacuum chamber.** Pozdeev, M.Yu. Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Serpukhov (USSR). Inst. Fiziki Vysokikh Ehnergij. 1989. 13p. (In Russian). Order Number DE90634027. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The transverse impedances of conical transitions and fast demountable joints in the vacuum chamber of the UNK are calculated. The characteristics of resonances at frequences greater than ≈ 6 GHz are studied. The violation of periodicity in the chamber resonance elements is taken into account by the probability technique. The UNK transverse beam instability region at high frequencies is evaluated. 6 refs.; 3 figs.

41445 (IFVE-OUNK–89-174) **SPP2 magnetic optics with β^*=0.5 m and pp-bar beam sharing system in the UNK-2.** Nosochkov, Yu.M. Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Serpukhov (USSR). Inst. Fiziki Vysokikh Ehnergij. 1989. 16p. (In Russian). Order Number DE90634028. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The possibility of luminosity increase in the pp-bar option of the UNK by means of β-function reduction in the crossing point. The optics of the low-beta insertion providing the value of β^*=0.5 m is discussed. To reduce the mutually destabilizing beam-beam effect of p and p-bar bunches, circulating in the same vacuum chamber of the UNK-2, a beam sharing system is being suggested. This scheme is based on the helical separation of colliding beams orbits which is induced everywhere with the exception of the experimental crossing points. 10 refs.; 8 figs.; 6 tabs.

41446 (IYaF–89-3) **Phase convection during colliding interaction and beam lifetime in electron-positron storage rings: 3. Lifetime limiting by total sets of resonances.** Gerasimov, A.L.; Dikanskij, N.S. AN SSSR, Novosibirsk (USSR). Inst. Yadernoj Fiziki. 1989. 29p. (In Russian). Order Number DE90634031. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The lifetime of a beam in electron-positron storage rings with respect to the data on the existence of an universal excitation mechanism by phase convection resonances, i.e. phase density fluxes circulating in closed circuits is studied. The effect of separate isolated resonances of different orders on beam lifetime is investigated. Lifetime dependence on the working point and nonideality of a storage ring (residual beam deflection, machine nonlinearity) is also studied. On the basis of comparison with experimental data, the conclusion is made that many phenomena connected with beam lifetime limitation in electron-positron storage rings are explained by the effect of phaseconvection excited by colliding interaction. 7 refs.; 20 figs.; 1 tab.

41447 (KEK–89-12, pp. 59-84) **First experiments for the electron stretcher ring ELSA.** Schwille, W.J. (Bonn Univ. (Germany, F.R.). Physikalisches Inst.). National Lab. for High Energy Physics, Tsukuba, Ibaraki (Japan). Sep 1989. (CONF-8810498–: Workshop on the experiments by polarized proton and electron beams, Tsukuba (Japan), 27-28 Oct 1988). In *Proceedings of the workshop on the experiments by polarized proton and electron beams.* Order Number DE90777829. Available from NTIS (US Sales Only), PC A11/MF A01.

This survey concentrates on a few selected topics and shows the continuation of the experimental lines as well as the new potentialities of a 100 % duty factor accelerator. (author).

41448 (SSC–29) **Normal form algorithm on non-linear symplectic maps.** Forest, E. Lawrence Berkeley Lab., CA (USA). SSC Central Design Group. Apr 1985. 19p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-89ER40486. Order Number DE90014084. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

In this paper we will look at normal form procedures applied on non-linear symplectic maps. Our attention is focused on the non-linear part of the map only. A knowledge of Lie operators is assumed. The map we will examine is relevant to the study of storage rings.

41449 (SSC–36) **The dependence of single particle stability on net chromaticity in CESR, near Q_h = 9 + 1/3.** Peggs, S. Lawrence Berkeley Lab., CA (USA). SSC Central Design Group. 1984. 4p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-89ER40486. Order Number DE90014093. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

It was originally suggested on purely theoretical grounds that the synchrobetatron sidebands of non-linear resonances, caused by betatron tune modulation, could lead to chaos, or stochasticity. This happens with both beam-beam and magnetic resonances, when the sidebands, which are typically as wide as the main resonance, overlap. The overlap criterion becomes more severe for lower frequency modulations. A real experiment with the non linear lens in the SPS was in semi-quantitative agreement with numerical experiments, and with the one dimensional theory. The SPS experience with the beam-beam effect is also in reasonable quantitative agreement with numerical models, and one dimensional theory, although only a limited amount of real experimental data is available. Dynamic aperture experiments made at CESR in April 84 are presented, showing the importance of the net chromaticity. Experimental results are compared to tracking results from the code EVOL, with qualitative, or semi-quantitative, agreement. Possible experimental improvements are described, and final conclusions are drawn. Both real and numerical experiments show strong dependencies on the net chromaticity.

41450 (SSC–45) **Elementary design and scaling considerations of storage ring colliders.** Chao, A.W. Lawrence Berkeley Lab., CA (USA). SSC Central Design Group. [1985]. 17p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-89ER40486. (CONF-850771–13: SLAC summer school on the physics of high energy particle accelerators, Stanford, CA (USA), 15-26 Jul 1985). Order Number DE90014091. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

This article is a compilation of some considerations encountered in the design of storage ring colliders. It consists of two chapters. The first chapter describes an approach to the collider design from a particular point of view at an elementary level. The second chapter discusses a few semi-empirical scaling properties in the collider parameters.

44 INSTRUMENTATION

Refer also to citation(s) 42256

4401 Radiation Instrumentation

Refer also to citation(s) 40703, 40731, 40969, 41121, 41350, 42008, 42209, 42214, 42225, 42235, 42251, 42292, 42297

41451 (CEA-DPHPE–89-17) **Progress Report: Feasibility Study of an Indium Scintillator Solar Neutrino Experiment.** Bellefon, A. de (College de France, 75 - Paris (FR). Lab. de Physique Corpusculaire); Barloutaud, R.; Borg, A.; Ernwein, J.; Mosca, L. CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Dept. de Physique des Particules Elementaires. Sep 1989. 37p. (LPC–89-24). Order Number DE90508322. Available from NTIS (US Sales Only), PC A03/MF A01.

In this document, we report on the progress made to demonstrate the feasibility of an experiment which would measure for the first time the two line sources of solar neutrinos resulting from electron capture by ^{7}Be and from the p-e-p reaction inside the sun. The detector under study consists of scintillator containing 10 tons of Indium.

41452 (CONF-900563–9) **Detection system characteristics using ^{252}Cf ionization chambers.** Mihalczo, J.T.; Hill, N.W.; Blakeman, E.D.; Pare, V.K. Oak Ridge National Lab., TN (USA). [1990]. 13p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. From 7. symposium on radiation measurements and applications; Ann Arbor, MI (USA); 21-24 May 1990. Order Number DE90011702. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

Because the number of neutrons and gamma rays and the energy spectrum of particles from spontaneous fission are well characterized for ^{252}Cf, it can be used as a timed source of fission neutrons and gamma rays. The first such usage incorporated a ^{252}Cf source into gas scintillators. This paper describes a timed source of neutrons and gamma rays made by depositing ^{252}Cf on one electrode of a parallel plate ionization chamber that can then be used for determining detection-system characteristics. The emission time of neutrons from spontaneous fission has also been determined by recording the emission time of prompt gamma rays from a ^{252}Cf source (not incorporated into a detector) adjacent to the surface of a solid or liquid scintillator. This well characterized source of neutrons can thus be used as a randomly pulsed source for a variety of applications. This paper illustrates the use of this type of source to determine the time resolution of detection systems, the efficiency for detection of neutrons between 0.5 and 5 MeV, the effectiveness of pulse shape discrimination systems, and the overall efficiency for detection of prompt fission gamma rays. 11 refs., 3 figs.

41453 (CONF-9009150–3) **On-site method for acquisition and analysis of sensor data.** Emery, M.S.; Blair, M.S.; Nyquist, J.E. Oak Ridge National Lab., TN (USA). [1990]. 7p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. From Sensors expo conference; Chicago, IL (USA); 11-13 Sep 1990. Order Number DE90011649. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Oak Ridge National Laboratory (ORNL) has developed an ultrasonic ranging and data system (USRADS) and interfaced the system with several types of survey instruments. The system measures the time of flight of an ultrasonic chirp between the surveyor's backpack and fixed receivers to determine location. Survey data are transmitted from the backpack to a computer via an RF data link and logged into a data file. Thus far a gamma scintillometer and a Geonics EM31 terrain conductivity meter have been interfaced to the system. An x-ray fluorescence spectrometer is in the final stages of testing, and work is presently under way to interface a photoionization trace gas analyzer. Digital output devices are connected via RS232 interface, and analog output devices are digitized by an 8-bit analog/digital converter (ADC). Future interfacing of other instruments should be relatively easy since these data structures will include most types of instrument outputs. 4 refs., 5 figs.

41454 (DOE/ER/03130–268) **Streamer tube readout electronics.** Rossi, D. (Brown Univ., Providence, RI (USA). Dept. of Physics); Widgoff, M.; Alyea, E.D. Brown Univ., Providence, RI (USA). Dept. of Physics. 21 Mar 1989. 22p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76ER03130. Order Number DE90014343. Available from NTIS, PC A03/MF A01; OSTI; INIS.

Pulses from the streamer chambers, taken from the wires and/or from read-out strips, provide triggers and tracking information. Here we are not concerned with the triggers, but assume a trigger has been formed, and we describe the read out of x (parallel to the wire) and y signals for each streamer chamber to give location information for particle trajectories.

41455 (EUR–11363) **Beta dosimetry.** Commission of the European Communities, Luxembourg (Luxembourg). 1988. 314p. (CONF-8705406–: 5. Information seminar on the radiation protection dosemeter intercomparison programme, Bologna (Italy), 25-27 May 1987). Available from NTIS (US Sales Only), PC A14/MF A01.

This report includes the papers presented at the fifth information seminar on the radiation protection dosemeter intercomparison programme which was held at the Centro Ricerche Energia - Ezio Clementel of the ENEA in Bologna from 25 to 27 May 1987. It contains an account of an intercomparison exercise for personal beta dosemeters which was started in 1986 and completed in early 1987, comments by the participants, a summary of the discussions, various contributions on beta dosimetry, and miscellaneous topics relating to radiation protection dosimetry: standardization, quality assurance, dosimetry procedures in Member States, the USA and Japan.

41456 (ICR–201-89-18) **Search for neutrino events in the Kamiokande-II detector in correlation with the solar-flare activity in March 1989.** Hirata, K.S. (and others); Kajita, T.; Kifune, T. Tokyo Univ., Tanashi (Japan). Inst. for Cosmic Ray Research. Dec 1989. 13p. (OULNS–89-11). Order Number DE90508085. Available from NTIS (US Sales Only), PC A03/MF A01.

A search has been made for neutrino events (E_ν > or approx. 50 MeV) in the Kamiokande-II water Cherenkov detector in correlation with the great solar-flare activity observed in March 1989. No evidence was obtained for such a correlation. Upper limits are separately given for the optical importance 4, 3, and 2 flares for both time-integrated and time-averaged solar-flare ν_e fluxes at E_ν = 50 MeV and 100 MeV. At E_ν = 100 MeV, the 90% confidence-level upper limit for the time-integrated ν_e flux per importance 4 (3) flare is 3.5 x 10^7 (1.4x10^7) cm$^{(minus)2}$. Even the upper limit for the importance 4 flare is considerably lower than the ν_e flux at the corresponding energy needed to explain the excess neutrino captures reported in some of the ^{37}Cl experimental runs when large solar flares occurred. A search has also been made for low-energy events (recoil $e^{\pm}$ energy > or approx. 10 MeV) in correlation with importance $\geq$ 2 flares and with the solar proton flux $\geq$ 10 MeV. Again, no significant signal has been observed. (author).

41457 (IFVE-OEF–89-92) **Data acquisition system of the GAMS-2000 hodoscopic spectrometer.** Alde, D. (Los Alamos National Lab., NM (USA)); Binon, F.; Gouanere, M. Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Serpukhov

(USSR). Inst. Fiziki Vysokikh Ehnergij. 1989. 22p. (In Russian). Order Number DE90634176. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

An analog summation system for the signals of the 1532 lead-glass counters of the GAMS-2000 hodoscope spectrometer id described. It is destined to fast determine (30 ns) the energy deposited by photons (electrons) and to produce the trigger of the first and second levels. The system is built of active adders, connected in three cascades. Differential discriminator and fast ADC, with coherent noise reduction, are used for the amplitude analysis. The system is computer controlled. It has been used in the experiment at the 70 GeV IHEP accelerator studying meson production in central hadron collisions. 14 refs.; 12 figs.; 1 tab.

41458 (IFVE-ONF–89-100) **General organization of the GRAND program for data analysis from the IHEP-JINR neutrino detector.** Koroleva, T.K.; Mukhin, S.A.; Spiridonov, A.A. Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Serpukhov (USSR). Inst. Fiziki Vysokikh Ehnergij. 1989. 21p. (In Russian). Order Number DE90634177. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The general organization of the GRAND computer program for the off-line data analysis from the IHEP-JINR neutrino detector was described. The comparison of GRAND's architecture with those ones for other experiments has been made. The technology of GRAND program development was considered. This technology is based on concepts of execution phase, program event and the definite concept of program module. The realized control part of the GRAND program in the frame of proposed technology was described. 23 refs.

41459 (IFVE-ONF–89-149) **Calorimeter detector consisting of a $KMgF_3$ scintillator and parallel-plate avalanche chamber.** Buzulutskov, A.F.; Turchanovich, L.K.; Vasil'chenko, V.G. Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Serpukhov (USSR). Inst. Fiziki Vysokikh Ehnergij. 1989. 9p. Order Number DE90634178. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

Submitted to NIM.

Scintillations of a $KMgF_3$ crystal have been detected in the parallel-plate avalanche chamber with a TEA gaseous photocathode, the scintillation signal is shown to be much higher than the direct ionization one. The characteristic properties of the calorimeters on the basis of such structure with electrical and optical readout are discussed. 10 refs.; 4 figs.

41460 (INP–1371/PL) **Two lectures on track structure.** Waligorski, M.P.R. Institute of Nuclear Physics, Cracow (Poland). 1987. 76p. Order Number DE90634212. Available from NTIS (US Sales Only), PC A05/MF A01; OSTI; INIS.

In a series of two lectures the principles of track structure theory, developed by Katz and collaborators, are reviewed. The text is intended to serve as an introduction to the theory. Applications of the model to c-hit physical detectors and to biological systems are reviewed. The model relates the signal of a detector after doses of X and gamma radiations to its signal after heavy charged particle irradiations, and is applicable to a variety of physical dosimeters: alanine, thermoluminescence and the Fricke dosimeters, to the inactivation of enzymes and viruses, and to biological systems: description of survival and neoplastic transformations in mammalian cells. Application of the model to heavy-ion cancer radiotherapy and to radiation protection is discussed as well as the controversies around the track structure approach. The model suggests new insights to fundamental research in detector theory and in radiobiology and in their applications in radiotherapy and radiation protection. 41 refs., 39 figs. (author).

41461 (INT–209/I) **Determination of hydrogen in liquids by neutron thermalization.** Ciechanowski, M.; Bolewski, A.; Kreft, A. Institute of Physics and Nuclear Techniques, Cracow (Poland). 1987. 19p. (In Polish). Order Number DE90634213. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

A measuring technique for hydrogen determination in liquids flowing through pipelines based on neutron thermalization is described. With a fast neutron source emitting 5×10^5 neutrons/s and 200 s counting time, the relative standard deviation of hydrogen determination in liquid hydrocarbons by this technique is less than 0,5%. The usability of the technique for measuring the concentration of sulphuric acid is shown. 23 refs., 4 figs. (author).

41462 (INT–210/I) **A method of peak area determination for gamma-ray spectra.** Loska, L. Institute of Physics and Nuclear Techniques, Cracow (Poland). 1987. 9p. Order Number DE90634147. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

A modification of the "total peak area" (TPA) method is proposed. Calculations were done in order to compare the new method and the TPA one. The modification can also be applied to other known peak area determination methods. 13 refs., 2 figs. (author).

41463 (IYaF–89-39) **Multiwire proportional chamber for the digital X-ray radiography.** Baru, S.E.; Khabakhpashev, A.G.; Shekhtman, L.I. AN SSSR, Novosibirsk (USSR). Inst. Yadernoj Fiziki. 1989. 23p. (In Russian). Order Number DE90634214. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

A fast-acting single-coordinate multiwire proportional chamber for digital X-ray radiography is described. To have a constant resolution over the whole chamber length with a high fast-action and quantum effectiveness the anode wires in the chamber are not located in parallel but in the radial directions with centre in the focus of the system X-ray tube. To compensate the change in the gas gain along anode wires the cathode planes are inclined relative to the anode one in a proper way. Chamber characteristics are the following spatial resolution is 1.2 mm, efficiency 28% for photon energy of $\approx$ 60 keV fast action is 600 kHz per a channel. 6 refs.; 13 figs.

41464 (JINR–13-89-279) **Electronic modules for spectrometric measurements with semiconductor detectors.** Akimov, Yu.K.; Banifatov, A.E.; Gleisberg, F.; Do Hoang Cuong; Kalinin, A.I.; Merzlyakov, S.I.; Tyupikov, V.K. Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems. 1989. 17p. (In Russian). Order Number DE90634151. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Electronic modules for semiconductor detectors are described. They are a high-voltage supply unit (0-5 kV) with a low pulsation level (<5 mV) and good stability (0.01%/deg C); a preamplifier and amplifier allowing operation at a high loading of input pulse count (to 10^5 pulse/s from ^{60}Co), a pule-up rejector, a fast amplifier and a synchronizer for writing to the buffer memory. All modules, except the preamplifier, are made in the CAMAC standard. A possible way of using the above modules in a two-arm spectrometer is described. 10 refs.; 11 figs.

41465 (JINR–13-89-297) **PCA/INCREMENT MEMORY interface for analog processors on-line with PC-XT/AT IBM.** Biri, S.; Buttsev, V.S.; Molnar, J.; Samojlov, V.N. Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy. 1989. 6p. (In Russian). Order Number DE90634152. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

Submitted to Prib. Tekh. Ehksp.

The functional and operational descriptions on PCA/INCREMENT MEMORY interface are discussed. The following is solved with this unit: connection between the analogue signal processor and PC, nuclear spectrum acquisition up to 2^{24}-1 counts/channel using increment or decrement method, data read/write from or to memory via data bus PC during the spectrum acquisition. Dual ported memory organization is 4096x24 bit, increment cycle time at 4.77 MHz system clock frequency is 1.05 μs. 6 refs.; 2 figs.

41466 (JINR–13-89-445) **Semiconductor microstrip detector with a resistive layer.** Barabash, L.S. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems); Bel'tsazh, E.; Mal'tsev, Eh.I.; Mesarosh, L.; Petukhov, Yu.P.; Pimenov, A.G.; Sandukovskij, V.G.; Gurov, Yu.B. Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems. 1989. 8p. (In Russian). Order Number DE90634153. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

Silicon one-coordinate detector made on the basis of a continuous position-sensitive counter and external system of readout strip is described. The resistive layer of the detector which is necessary to obtain charge distribution fron the incident particle was formed by a thin undepleted region of the detector. The active area of the

detector was 21x5 mm^2 and its thickness was 812 μm. A possibility to obtain the position precision (using centroid finding of the charge) $\approx$25 μm for α-particles of ^{239}Pu for the strip pitch of 0.5 mm is shown. 8 refs.; 6 figs.

41467 (JINR-E-10-89-302) **Live histograms in moving windows: Example of implementation.** Zhil'tsov, V.E. Joint Inst. for Nuclear Research, Dubna (USSR). 1989. 12p. Order Number DE90634243. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Application of computer graphics for specific hardware testing is discussed. The hardware is position sensitive detector (multiwire proportional chamber) which is used in high energy physics experiments, and read-out electronics for it. Testing program is described (XPERT), which utilises multi-window user interface. Data are represented as histograms in windows. The windows on the screen may be moved, reordered, their sizes may be changed. Histograms may be put to any window, and hardcopy may be made. Some program internals are discussed. The computer environment is quite simple: MS-DOS IBM PC/XT, 256 KB RAM, CGA, 5.25" FD, Epson MX. 4 refs.; 7 figs.

41468 (JINR-R-10-89-293) **Version of the UCD UNK high level trigger system on the base of MULTIBUS II standard.** Govorun, N.N. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Computing Techniques and Automation); Golutvin, I.A.; Kadantsev, S.G.; Kotov, V.M.; Krumshtejn, Z.V.; Mitsel'makher, G.V.; Shirikov, V.P.; Vorob'ev, A.P.; Glebov, V.Yu.; Sergeev, V.A. Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Computing Techniques and Automation. 1989. 10p. (In Russian). Order Number DE90634185. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

This is a proposal for the version of high level triggering subsystem (HLT) for UCD. HLT is a part of the complete data acquisition system (DAQ) for UCD UNK. The hardware and software HLT complex must provide the real time acquisition and handling of data taken from the second level triggering subsystem in DAQ UCD. 7 refs.; 4 figs.

41469 (JINR-R-10-89-319) **Identification of the E and ΔE signals in scintillation telescopes.** Tran Trong Vinh (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions); Subbotin, V.G.; Fomichev, A.S.; Heidel, K. Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions. 1989. 6p. (In Russian). Order Number DE90634148. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

The principle of the work of the analog circuits, which serve to separate E and ΔE signals from the anode signal of the photomultiplier is described. The AVP-150 photomultiplier detects the combined light impulse of the scintillation telescope due to different sorts of the ionization radiations. The telescope consists of the CsI(Tl) layer 50x0.030 mm and of the plastic cylinder 50x50 mm. The α-particles of the ^{227}Ac, ThC" (E<8.78 MeV) were distinguished from γ-rays of the Pu(Be) radioactive source (E<4.44 MeV). 6 refs.; 3 figs.

41470 (JINR-R-13-89-208) **Investigation of the possibilities of a photoelectric registering system for measurements of Cherenkov radiation intensity.** Zrelov, V.P.; Kuz'min, E.S.; Tyutyunnikov, S.I.; Shalyapin, V.N. Joint Inst. for Nuclear Research, Dubna (USSR). 1989. 5p. (In Russian). Order Number DE90634186. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

The paper is devoted to the investigation of the possibilities of a photoelectric registering system (photodetector) with a Cherenkov device designed for measurement of the mean beam energy in the phasotron of the Laboratory of Nuclear Problems. The photodetector consisted of an electron to optical converter on the micro-channel plate and a dissector type LI-605 connected by means of fiber optics. The photodetector is found to allow measurements of the Cherenkov radiation intensity distribution within a macroimpulse of the accelerator ($\approx$ 40 μs) for a proton beam with the energy 655 MeV and intensity 10^7 - 10^8 protons/s. 4 refs.; 3 figs.

41471 (JINR-R-13-89-209) **A module for forming stabilization levels of the voltage of a capacitor bank at the setup SLON.** Buriev, I.T. (Tadzhikskij Gosudarstvennyj Univ., Dushanbe (USSR)); Kaplin, V.I.; Kovalenko, A.D.; Sajfulin, Sh.Z. Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy. 1989. 5p. (In Russian). Order Number DE90634187. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

The unit for forming stabilization levels of the voltage of capacitor bank at the setup SLON is described. It operates in conjunction with the CHSH-1513 digital voltmeter and is used to control the operation of rectifiers in a charging circuit of the capacitor bank. The unit provides a possibility of voltage stabilization of the capacitor bank over a range of 5 kV with an accuracy of $\pm$ 0.5 V. 3 refs.; 3 figs.

41472 (JINR-R-13-89-361) **On possible use of avalanche counters in vertex detectors.** Khazins, D.M. Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems. 1989. 8p. (In Russian). Order Number DE90634188. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

Submitted to the Organizing Committee of the Intern. Symp. Experiments and Technique in High Energy Physics, Bechyne, Chechoslovakia, June 1989.

The requirements to vertex detectors for B-meson research on fixed target accelerators are discussed. The basic principles of parallel plate avalanche counter operation are presented as well as characteristics of the counter exploited in heavy ions physics. The experimental results of relativistic particle detection are given. A variant of such a counter for the vertex detector is considered. 13 refs.; 8 figs.

41473 (JINR-R-13-89-458) **Charge device at the setup SLON.** Buriev, N.T. (Tadzhikskij Gosudarstvennyj Univ., Dushanbe (USSR)); Kaplin, V.I.; Kovalenko, A.D.; Muryzin, A.G. Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy. 1989. 5p. (In Russian). Order Number DE90634189. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

The charge device with the energy capacity bank of 3.2 MJ with high uniformity of the charged current and efficiency is described. The use of the phase-pulse control method of the 3-phase thyristor rectifier in conjunction with the one-channel control system made it possible to achieve the symmetry of master pulses 0.1 deg over the whole region of the regulating angle (0-90 deg) when the angle of the switching of each thyristor pair is formed by the same device of the phase shift with the following pulse distribution in thyristor pairs. 2 refs.; 3 figs.

41474 (JINR-R-13-89-459) **A control unit of the charged device at the setup SLON.** Buriev, N.T. (Tadzhikskij Gosudarstvennyj Univ., Dushanbe (USSR)); Kaplin, V.I.; Kovalenko, A.D. Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy. 1989. 4p. (In Russian). Order Number DE90634190. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

A high current rectifier control unit of the charged arrangement for a capacity bank of 1.5 MJ at the setup SLON is described. The unit generates a sawtooth voltage over a range of 0 to +10 V with a step of about 2.5 mV under a given programme and makes it possible to control the capacitor bank charge both in a single and a cyclic mode. 4 refs.; 2 figs.

41475 (JINR-R-15-89-98) **Identification of the ionization emission using the phoswich counter technique.** Kamanin, V.V. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions); Kugler, A.; Sobolev, Yu.G.; Fomichev, A.S.; Batsev, S.; David, I.; Zorenko, Yu.V. Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions. 1989. 9p. (In Russian). Order Number DE90634150. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

The scheme of the experimental work and the data acquisition systems to obtain the two dimension event matrix are reported for the scintillational phoswich counter. The experimental data of the α-γ identification from ^{227}Ac and Pu(Be) sources using the phoswich counter on the of CsI(Tl) 40x30 mm^2, CsI(Tl) 50x0.050 mm^2 + plastic 50x50 mm^2, $Y_3Al_5O_{12}$(Ce) 50x0.005 mm^2+$Y_3Al_5O_{12}$(Sc) 50x2.5 mm^2 with AVP-56 photomultiplier are shown. The some measuring is compared in the reaction ^4He(36

MeV)+^{209}Bi using solid state ΔE-E detector telescopes. The essential features, construction details and performance of phoswich detector are described. 10 refs.; 5 figs.; 1 tab.

41476 (JINR-R–15-89-130) **Rapid nuclear polarization by pulsed laser irradiation.** Gangrskij, Yu.P. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions); Hradecny, C.; Markov, B.N.; Naumov, Yu.V.; Zaretskij, D.F.; Izosimov, I.N.; Kozlinskij, A.V. Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions. 1989. 8p. (In Russian). Order Number DE90634149. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

Nuclear orientation induced by short (10^{-8} s) pulse of circularly polarized light was investigated. Tunable dye laser with pulsing power up to 15 kW used. Asymmetry in the angular distribution of ^{22}Na and ^{24}Na γ-rays was measured at sodium vapour irradiation by laser light with walve length 589.6 nm. Nuclear polarization about 10% was reached in time shorter than laser pulse duration. 12 refs.; 4 figs.; 2 tabs.

41477 (Juel–2276) **Construction of a low-temperature Eulerian cradle for neutron diffractometry and measurements on a TbB_4 monocrystal for profile analysis of temperature-dependent split-up of reflection.** Elf, F. Kernforschungsanlage Juelich GmbH (Germany, F.R.). Inst. fuer Festkoerperforschung. Apr 1989. 102p. (In German). Order Number DE90510131. Available from NTIS (US Sales Only), PC A06/MF A01.

The main goal of this study was the construction and test of a circular Eulerian cradle for the temperature range from 300 K to 4 K. The discovery that modified stepping motors also work perfectly in liquid helium, allowed the realization of a new construction principle: The whole Euler cradle including the stepping motors is completely arranged in the testing chamber of a cryostat. The realization of this concept required sophisticated production techniques and a careful selection and adjustment of materials, dry lubricants, electrical insulation material, adhesives, etc., which guarantee a perfect functioning within the whole temperature range. As a result, a patented device has been developed, which is practically not subject to any angular restrictions and which is - as concerns precision requirements - comparable to commercial Euler cradles for room temperature. First measurements with the new low temperature Euler cradle on a TbB_4 monocrystal showed that the profile of the reflexes is temperature dependent. (orig./HP).

41478 (LBL–28667) **A monolithically integrated detector-preamplifier on high-resistivity silicon.** Holland, S.; Spieler, H. Lawrence Berkeley Lab., CA (USA). Feb 1990. 6p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00098. (CONF-900143–35: Institute for Electronic and Electrical Engineers (IEEE) nuclear science symposium, San Francisco, CA (USA), 15-19 Jan 1990). Order Number DE90013844. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

A monolithically integrated detector-preamplifier on high-resistivity silicon has been designed, fabricated and characterized. The detector is a fully depleted p-i-n diode and the preamplifier is implemented in a depletion-mode PMOS process which is compatible with detector processing. The amplifier is internally compensated and the measured gain-bandwidth product is 30 MHz with an input-referred noise of 15 nV/$\sqrt{}$Hz in the white noise regime. Measurements with an Am^{241} radiation source yield an equivalent input noise charge of 800 electrons at 200 ns shaping time for a 1.4 mm^2 detector with on-chip amplifier in an experimental setup with substantial external pickup.

41479 (LPC–89-28) **Installation of GEANT on a T800 transputer card.** Jejcic, A. (College de France, 75 - Paris (FR). Lab. de Physique Corpusculaire); Maillard, J.; Silva, J.; Boun, K.K. College de France, 75 - Paris (France). Lab. de Physique Corpusculaire. 1989. 8p. (In French). Order Number DE90508323. Available from NTIS (US Sales Only), PC A02/MF A01.

The GEANT installation and verification on a single node of a transputer T800 based parallel computer T.Node is reported. Problems encountered are summarised and performances are given for several simulation conditions in high energy physics. Comparison is made with results obtained on other systems.

41480 (LUNKDL-NKOO–1018-001-073-1990) **Structural studies using X-ray absorption and scattering techniques.** Ericson, Agneta. Lund Univ. (Sweden). Dept. of Inorganic Chemistry I. 27 Nov 1989. 73p. Order Number DE90634215. Available from NTIS (US Sales Only), PC A04/MF A01; OSTI; INIS.

The thesis presents extended X-ray absorption fine structure, EXAFS, and large angle X-ray scattering, LAXS, techniques; instrumentation, data collection and reduction, and applications. These techniques have been used to determine the structures of magnesium halides and organomagnesium halides in diethyl ether and tetrahydrofuran solution. The iodides were used for the LAXS measurements and Br K edge EXAFS data were collected for the corresponding bromides. Two different complexes are present in the diethyl ether solution of magnesium iodide: a polymeric chain-type structure where magnesium is tetrahedrally coordinated, and dimeric complex with octahedrally coordinated magnesium. Solvated MgI^+ is the dominating species in tetrahydrofuran solution. The organomagnesium halides are present in diethyl ether solution as both solvated monomeric and dimeric complexes. Magnesium coordinates a halide ion, an alkyl or aryl group and four solvent molecules octahedrally in the monomeric complex. In the dimeric complex magnesium is octahedrally coordinated by two bridging halide ions, an alkyl or aryl group and three solvent molecules. The distribution of monomeric and dimeric complexes in various solutions are given by a dimerisation constant, K_d. The results indicate that the Schlenk equilibrium is present in these solutions in an extended form. In diethyl ether solution, where MgX_2 does not dissociate, no MgX_2 complex and thereby no Schlenk equilibrium has been observed. In tetrahydrofuran solution MgI_2 has dissociated into mainly MgI^+ and I^-. This indicates that the concentration of MgI_2 is low and that the Schlenk equilibrium should be expanded even further to include the dissociation equilibrium of the magnesium halide. Fe K edge EXAFS data collected for the semireduced form of protein A of methane monooxygenase from Methylococcus capsulatus are presented. (139 refs.).

41481 (MPI-PAE/Exp.El.–224) **A concept for particle identification for a B-factory detector.** Holl, I.; Lorenz, E.; Mageras, G. Max-Planck-Institut fuer Physik und Astrophysik, Muenchen (Germany, F.R.). Werner-Heisenberg-Inst. fuer Physik. May 1990. 16p. Order Number DE90510259. Available from NTIS (US Sales Only), PC A03/MF A01.

A new concept for a particle identifier in a detector for a B-factory is described. The identifier is based on a multi cell aerogel threshold Cerenkov counter. The individual cells are read out by wavelength shifter fibers coupled to avalanche photodiodes operated in the single photon trigger mode. A double layer of Aerogel with different refractive indices allows one to cover the momentum range from 0.4 to 2.7 GeV momentum. Expected performances, first tests and a development program are presented. (orig.).

41482 (ORNL/FTR–3649) **[Reconstruction of the trigger electronics for the WA80 experiment]: Foreign trip report, June 5, 1990–June 15, 1990.** Young, G.R. Oak Ridge National Lab., TN (USA). 26 Jun 1990. 5p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE90013396. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The traveler spent two weeks at CERN working with H. -A. Gustafsson of Lund University on a complete redesign of the trigger electronics used by the WA80 experiment at the CERN SPS. This "new trigger" incorporates much more programmable logic than previously and includes new monitoring electronics and digital oscilloscopes interfaced to the main on-line computer. This new trigger will see its first on-line use during the heavy-ion run scheduled for August 2 through September 2, 1990, at the SPS. Test of the new layout using the existing laser systems as signal sources will be performed in July 1990. Conversations were had with other members of WA80 present about the experimental setup for the August 1990 heavy-ion run at CERN. Finally, the traveler attended an all-day session of the dilepton working group chartered to consider dilepton and photon experiments using heavy-ion beams in CERN's to -be-proposed Large Hadron Collider (LHC). At this

meeting the traveler presented current plans for dimuon experiments at RHIC and commented on perceived difficulties for such a program at the LHC.

41483 (ORNL/FTR–3672) **[Enrichment services for chromium isotopes for the GALLEX [Gallium Experiment] international collaboration experiment on solar neutrino flux]: Foreign trip report, June 23–30, 1990.** Szady, A.J. Oak Ridge National Lab., TN (USA). 16 Jul 1990. 6p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE90014300. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Detailed discussions were held with members of the Gallium Experiment (GALLEX) international solar neutrino research collaboration concerning negotiations to provide $1.4 million in services to enrich ^{50}Cr for a ^{51}Cr neutrino source. The source will be used to calibrate the 20-ton gallium solar neutrino detector currently in place in the Gran Sasso Laboratory in Italy. Funding approval for the enrichment services is expected from the European Common Market by October 19, 1990. The discussions focused on the technical aspects of the enrichment, the health and safety requirements for handling the process gas, cost projections, schedule, the Work-for-Others contract, and the method of payment. Discussions were also held with members of the nuclear physics department at the University of Milan concerning the availability of isotopes enriched by the Calutron at the Oak Ridge National Laboratory. Very high purity material is needed to grow crystals for use in double beta decay detectors. Finally, working sessions were held to draft a coauthored paper on the results of using the gas centrifuge to remove trace quantities of ^{85}Kr from natural xenon. The paper will be submitted to Nuclear Instruments and Methods.

41484 (SSC–202) **Requirements for calorimetric jet mass reconstruction for high $p_\perp$ jets at the SSC.** Bay, A. (Lawrence Berkeley Lab., CA (USA)); Wang, E.M.; Bintinger, D.; Gilchriese, M.G.D.; Groom, D.E. Lawrence Berkeley Lab., CA (USA). SSC Central Design Group. Jan 1989. 10p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-89ER40486. Order Number DE90014649. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

We have studied two aspects of calorimetry for high $p_\perp$ jets at the SSC. First, the impact of shower containment on very high $p_\perp$ jets and quark compositeness has been studied. Second, the effect of calorimeter granularity on the mass reconstruction of a high $p_\perp$ W ($p_\perp$ > 500 GeV/c) producing jets has been examined in detail. We conclude, based on possible compositeness signatures only, that shower leakage has little effect on the compositeness signal for a calorimeter thickness greater than about eight absorption lengths. Mass resolution of very high $p_\perp$ W's reconstructed from hadronic decays of the W is strongly affected by intrinsic shower spreading as well as calorimeter granularity. These effects are quantified. 20 refs., 17 figs., 2 tabs.

4405 Thermal Instrumentation

Refer also to citation(s) 41266

41485 (FTINT–44-88) **Platinum-cobalt cast microwire thermal converters for the 0.4-300 K range.** Logvinenko, S.P.; Mikhina, G.F. AN Ukrainskoj SSR, Kharkov (Ukrainian SSR). Fiziko-Tekhnicheskij Inst. Nizkikh Temperatur. 1988. 12p. (In Russian). Order Number DE90632137. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Thermometric characteristcs of glass-insulated cast microwires of Pt-0,5 at. % Co and Pt-0,57 at. % Co are studied in the temperature range 0,4 to 300 K. Based on these alloys, miniature thermal converters are developed with electric resistance 500 to 1000 Ohms at 273 K. The proposed dimensions of the converters are 8 dia and 3 mm high, 5 dia and 5 mm high. The relative sensitivity of thermal converters reaches 2,6 $\%xK^{-1}$ at 0,4 K. 7 refs.; 3 figs.; 6 tabs.

41486 (FTINT–47-88) **Digital controlled temperature regulation and stabilization system.** Ofitserov, M.N.; Prentslau, N.N.; Kucheryavenko, N.A.; Beskorsyj, A.P.; Levchenko, N.M. AN Ukrainskoj SSR, Kharkov (Ukrainian SSR). Fiziko-Tekhnicheskij Inst. Nizkikh Temperatur. 1988. 12p. (In Russian). Order Number DE90632138. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

A digitally controlled electronic-mechanical temperature regulation and stabilization system is presented and its specifications are given. The system makes it possible to set any temperature within the range of 300-80 K and to maintain it with a root-mean-square instability of 0,3 per hour. 3 refs.; 5 figs.

41487 (N–90-21313) **Proceedings of the third infrared detector technology workshop.** McCreight, C.R. National Aeronautics and Space Administration, Moffett Field, CA (USA). Ames Research Center. Oct 1989. 459p. (NASA-TM–102209;A–89200;NAS–1.15:102209;CONF-8902188–: 3. infrared detector technology workshop, Moffett Field, CA (USA), 7-9 Feb 1989). Available from NTIS, PC A20/MF A03.

This volume consists of 37 papers which summarize results presented at the third infrared detector technology workshop, held February 7-9, 1989, at Ames Research Center. The workshop focused on infrared (IR) detector, detector array, and cryogenic electronic technologies relevant to low-background space astronomy. Papers on discrete IR detectors, cryogenic readouts, extrinsic and intrinsic IR arrays, and recent results from ground-based observations with integrated arrays were given. Recent developments in the second-generation Hubble Space Telescope (HST) infrared spectrometer and in detectors and arrays for the European Space Agency's Infrared Space Observatory (ISO) are also included, as are status reports on the Space Infrared Telescope Facility (SIRTF) and the Stratospheric Observatory for Infrared Astronomy (SOFIA) projects.

41488 (N–90-21313, pp. 19) **Stressed Ge:Ga photoconductors for space-based astronomy. (Is there life beyond 120 micron).** Beeman, J.W. (California Univ., Berkeley (USA)); Haller, E.E.; Hansen, W.L.; Luke, P.N.; Richards, P.L. National Aeronautics and Space Administration, Moffett Field, CA (USA). Ames Research Center. Oct 1989. (NASA-TM–102209;A–89200;NAS–1.15:102209;CONF-8902188–: 3. infrared detector technology workshop, Moffett Field, CA (USA), 7-9 Feb 1989). In *Proceedings of the third infrared detector technology workshop.* Available from NTIS, PC A20/MF A03.

Information is given in viewgraph form. Information is given on the characteristics of stressed Ge:Ga, a spring type stress cavity, mounting hardware, materials parameters affecting dark current, and the behavior of low dark current stressed Ge:Ga. It is concluded that detectors exist today for background-limited detection at 200 microns, that researchers are narrowing in on the significant parameters that effect dark current in stressed photoconductors, that these findings may be applied to other photoconductor materials, and that some creative problem solving for an ionizing effect reset mechanism is needed.

41489 (N–90-21313, pp. 35-44) **A 100 micro Kelvin bolometer system for SIRTF.** Bernstein, G.M.; Timbie, P.T.; Richards, P.L. National Aeronautics and Space Administration, Moffett Field, CA (USA). Ames Research Center. Oct 1989. (NASA-TM–102209;A–89200;NAS–1.15:102209;CONF-8902188–: 3. infrared detector technology workshop, Moffett Field, CA (USA), 7-9 Feb 1989). In *Proceedings of the third infrared detector technology workshop.* Available from NTIS, PC A20/MF A03.

Progress toward a prototype of 100 mK bolometric detection system for the Space Infrared Telescope Facility (SIRTF) is described. Two adiabatic demagnetization refrigerators (ADR's) were constructed and used to investigate the capabilities necessary for orbital operation. The first, a laboratory ADR, demonstrated a hold time at 0.1 K of over 12 hours, with temperature stability approx. 3 micro-K RMS achieved by controlling the magnetic field. A durable salt pill and an efficient support system have been demonstrated. A second ADR, the SIRTF flight prototype, has been built and will be flown on a balloon. Techniques for magnetic shielding, low heat leak current leads, and a mechanical heat switch are being developed in this ADR. Plans for construction of 100 mK bolometers are discussed. Three important cosmological investigations which will be carried out by these longest wavelength SIRTF detectors are described.

41490 (N–90-21313, pp. 85-115) **Germanium Blocked Impurity Band (BIB) detectors.** Haller, E.E. (Lawrence Berkeley Lab., CA (USA)); Baumann, H.; Beeman, J.W.; Hansen, W.L.; Luke, P.N.; Lutz, M.; Rossington, C.S.; Wu, I.C. National Aeronautics and Space Administration, Moffett Field, CA (USA). Ames Research Center. Oct 1989. (NASA-TM–102209;A–89200;NAS–1.15:102209;CONF-8902188–: 3. infrared detector technology workshop, Moffett Field, CA (USA), 7-9 Feb 1989). In *Proceedings of the third infrared detector technology workshop.* Available from NTIS, PC A20/MF A03.

Information is given in viewgraph form. The advantages of the Si blocked impurity band (BIB) detector invented by M. D. Petroff and M. G. Stabelbroek are noted: smaller detection volume leading to a reduction of cosmic ray interference, extended wavelength response because of dopant wavefunction overlap, and photoconductive gain of unity. It is argued that the stated advantages of Si BIB detectors should be realizable for Ge BIB detectors. Information is given on detector development, subtrate choice and preparation, wafer polising, epitaxy, characterization of epi layers, and preliminary Ge BIB detector test results.

41491 (N–90-21313, pp. 247-258) **Stressed detector arrays for airborne astronomy.** Stacey, G.J. (Max-Planck-Inst. fuer Physik und Astrophysik, Garching (Germany, F.R.)); Beeman, J.W.; Haller, E.E.; Geis, N.; Poglitsch, A.; Rumitz, M. National Aeronautics and Space Administration, Moffett Field, CA (USA). Ames Research Center. Oct 1989. (NASA-TM–102209;A–89200;NAS–1.15:102209;CONF-8902188–: 3. infrared detector technology workshop, Moffett Field, CA (USA), 7-9 Feb 1989). In *Proceedings of the third infrared detector technology workshop.* Available from NTIS, PC A20/MF A03.

The development of stressed Ge:Ga detector arrays for far-infrared astronomy from the Kuiper Airborne Observatory (KAO) is discussed. Researchers successfully constructed and used a three channel detector array on five flights from the KAO, and have conducted laboratory tests of a two-dimensional, 25 elements (5x5) detector array. Each element of the three element array performs as well as the researchers' best single channel detector, as do the tested elements of the 25 channel system. Some of the exciting new science possible with far-infrared detector arrays is also discussed.

41492 (N–90-21313, pp. 387-400) **SIRTF in high earth orbit.** Werner, M.W. (California Univ., Berkeley (USA)); Brooks, W.F.; Manning, L.A.; Eisenhardt, P. National Aeronautics and Space Administration, Moffett Field, CA (USA). Ames Research Center. Oct 1989. (NASA-TM–102209;A–89200;NAS–1.15:102209;CONF-8902188–: 3. infrared detector technology workshop, Moffett Field, CA (USA), 7-9 Feb 1989). In *Proceedings of the third infrared detector technology workshop.* Available from NTIS, PC A20/MF A03.

The goals, requirements and operation of the Space Infrared Telescope Facility (SIRTF) are discussed. Emphasis is upon an analysis of the options of high and low earth orbits for the mission. The consensus was that the high earth orbit offers significant scientific and engineering advantages for SIRTF.

41493 (UCRL–102750) **Error analysis of a ratio pyrometer by numerical simulation.** Gathers, G.R. Lawrence Livermore National Lab., CA (USA). May 1990. 22p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-9009152–2: 2. workshop on subsecond thermophysics, Torino (Italy), 20-21 Sep 1990). Order Number DE90011500. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

A numerical method has been devised to evaluate measurement errors for a three channel ratio pyrometer as a function of temperature. The pyrometer is simulated by computer codes, which can be used to explore the behavior of various designs. The influence of the various components in the system can be evaluated. General conclusions can be drawn about what makes a good pyrometer, and an existing pyrometer was evaluated, to predict its behavior as a function of temperature. The results show which combination of two channels gives the best precision. 12 refs., 12 figs.

41494 (UCRL–102751) **Error analysis by numerical simulation for a three-color pyrometer assuming a blackbody spectrum and a wavelength and temperature dependent emissivity.** Gathers, G.R. Lawrence Livermore National Lab., CA (USA). May 1990. 20p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-9009152–1: 2. workshop on subsecond thermophysics, Torino (Italy), 20-21 Sep 1990). Order Number DE90011504. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

A numerical method devised to test ratio pyrometers has been used to explore the fitting of a blackbody spectrum and an emissivity model that assumes linear wavelength dependence and arbitrary temperature dependence. The slope and intercept coefficients for the emissivity and the temperature form three unknowns. The equations for the output of the three channels can be solved simultaneously for the emissivity coefficients and the temperature at any given time using the corresponding measured channel outputs. The stability of the solution is tested a function of the temperature and equipment characteristics. 8 refs., 10 figs., 1 tab.

4406 Optical Instrumentation

Refer also to citation(s) 41272, 41322

41495 (CONF-9009150–2) **Single port, two color particle sensing system for characterizing wet steam.** Simpson, M.L. (Oak Ridge National Lab., TN (USA)); Maxey, L.C.; Muhs, J.D.; Azar, M.; Powell, H.; Ventrice, C. Oak Ridge National Lab., TN (USA). [1990]. 9p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. From Sensors expo conference; Chicago, IL (USA); 11-13 Sep 1990. Order Number DE90011707. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The major emphasis of the research effort described in this paper is to develop a monitor that characterizes the size and velocity of the liquid phase in wet steam, on-line. Such a monitor would indicate potentially hazardous conditions, reduce downtime, increase operating efficiency and safety, and reduce downtime, increase operating efficiency and safety, and thus would be cost effective. Continuously monitoring the steam quality, on-line, thus helps to control the undesirable side effects of a liquid phase in the live steam line and turbines. A monitor, however, is subject to certain restrictions. Wet steam must be measured in situ since removing the steam from its environment distorts the parameters of interest. The steam flow is hostile measurement environment, thus any parts of an on-line monitor in contact with the steam must be capable of withstanding long term exposure to extremes in temperatures and pressures. Because the sizes and distributions of particles vary with location inside the pipe, the monitor must also be capable of making measurements as a function of the pipe radius. Finally, since the measurement is made in a production environment, limited access to the steam is available. In the following paper, results from an Oak Ridge National Laboratory (ORNL) program to investigate a new probe for making liquid phase measurements in steam are discussed. The probe accesses the steam noninvasively through a single optical port, and uses multiple wavelength visibility measurements to characterize the wet steam particles. The new optical technique is described and the results obtained from initial experiments using aerosol particles are discussed. 23 refs., 7 figs., 1 tab.

41496 (SAND–90-0518) **Oscilloscope photography at NTS [Nevada Test Site].** Robertson, C.E. Sandia National Labs., Albuquerque, NM (USA). Jun 1990. 21p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. Order Number DE90013630. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

High-quality recording of an oscilloscope waveform is usually made on photographic film. Achieving high quality, especially in a possible radiation environment and with fast sweep speeds, requires a thorough understanding of all aspects of the imaging and recording processes. This paper represents a compilation of techniques and procedures to achieve optimum oscilloscope imagery under adverse conditions and in an environment where unwanted radiation is a possibility. 10 figs., 1 tab.

41497 (SAND–90-0768C) **Optical surveillance equipment for the late 1990's.** Johnson, C.S. Sandia National Labs., Albuquerque, NM (USA). [1990]. 8p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. (CONF-9007106–22: Institute of nuclear materials management conference, Los Angeles, CA (USA), 15-18 Jul 1990). Order Number DE90013865. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Techniques for optical surveillance and storage in the last two decades have been mainly centered first around film cameras and then around video cameras and time lapse video tape recorders. There is every indication that these technologies will have vanished by the end of the 1990's. The evolution of video technology is taking place at a staggering pace driven by the new solid state devices being produced by the semiconductor industry. While the safeguards industry may be quite satisfied with the performance of the present image hardware available to them, the obsolescence of today's technology will occur rapidly. This paper will look at the development trends in today's technology and see what they indicate for image surveillance developments in next few years. 3 figs.

41498 **Reverse saturable absorption in metal cluster compounds.** Tutt, L.W. (Hughes Research Laboratories, 3011 Malibu Canyon Road, Malibu, California 90265 (USA)); McCahon, S.W. *Optics Letters (USA),* 15(12): 700-702 (15 Jun 1990). Contract 9945605.

We report a new family of organometallic compounds that exhibit optical limiting through reverse saturable absorption. The optical limiting properties of the metal cluster compounds $HFeCo_3(CO)_{12}$, $[NEt_4]^+FeCo_3(CO)^-_{12}$, $HFeCo_3(CO)_{10}(PMe_3)_2$, and $HFeCo_3(CO)_{10}(P(C_6H_5)_3)_2$ were measured at 532 nm using 8-nsec pulses. Pulse narrowing from 8 to 4 nsec was observed. The data indicate that the optical-limiting properties are essentially independent of the type of counter ion substituted in the compound but dependent on the ligand-type substitution.

41499 **High-resolution Brillouin gain spectroscopy in fused silica.** Faris, G.W. (Molecular Physics Laboratory, SRI International, Menlo Park, California 94025 (USA)); Jusinski, L.E.; Dyer, M.J.; Bischel, W.K.; Hickman, A.P. *Optics Letters (USA),* 15(12): 703-705 (15 Jun 1990). Contract 9945605.

We report what is to our knowledge the first high-resolution Brillouin gain spectrum in a solid. Resonances corresponding to longitudinal (compressional) and transverse (shear) acoustic waves in fused silica are observed with good resolution and a high signal-to-noise ratio. Absolute gain coefficients, linewidths, and Brillouin frequency shifts are measured. The agreement with previously measured values is good.

4408 Miscellaneous Instrumentation

Refer also to citation(s) 40315, 40425, 41043, 41121, 41268, 41273, 41274, 41576, 41786, 42065

41500 (CPIA-PUBL–515-VOL-1, pp. 471-478) **RF modal quantity gaging.** Vanleuven, K. Johns Hopkins Univ., Baltimore, MD (USA). May 1989. (CONF-8905134–: JANNAF propulsion meeting, Cleveland, OH (USA), 22-25 May 1989). In *The 1989 JANNAF Propulsion Meeting, volume 1.* Available from NTIS, PC A25/MF A04.

The primary objective is to provide a concept of a radio frequency (RF) modal resonance technique which is being investigated as a method for gaging the quantities of subcritical cryogenic propellants in metallic tanks. Of special interest are the potential applications of the technique to microgravity propellant gaging situations. The results of concept testing using cryogenic oxygen, hydrogen, and nitrogen, as well as paraffin simulations of microgravity fluid orientations, are reported. These test results were positive and showed that the gaging concept was viable.

41501 (CPIA-PUBL–515-VOL-1, pp. 479-488) **Electronically Variable Pressure Regulator (EVPR).** Reinicke, R.H. (Eaton Corp., El Segundo, CA (USA)); Nelson, R.O.; Hurlbert, E. Johns Hopkins Univ., Baltimore, MD (USA). May 1989. (CONF-8905134–: JANNAF propulsion meeting, Cleveland, OH (USA), 22-25 May 1989). In *The 1989 JANNAF Propulsion Meeting, volume 1.* Available from NTIS, PC A25/MF A04.

A new programmable electronically variable pressure regulator (EVPR) concept accurately controls the local outlet or remote system pressure. It uses an integral pulse width modulated rare earth permanent magnet motor operating in response to redundant pressure transducer feedback signals. The EVPR is a simple single stage device that does not use dynamic seals or pilot valving. Conversion of partial revolution motor torque to poppet lifting force is accomplished by pure flexure action to avoid using bearings. The flexure drive (called the ROTAX) has a variable lead to minimize motor weight and power consumption. Breadboard tests were completed successfully on two critical design elements of the EVPR: the ROTAX and the motor. The ROTAX cable system was tested for 250,000 cycles without failure. The breadboard motor met the basic design requirements including the design torque and power consumption. Prototype parts were fabricated, and testing of the prototype EVPR has started. It is PC computer controlled to facilitate programming, data acquisition and analysis. A lightweight dedicated microprocessor is planned for the flightweight EVPR.

41502 (JINR–13-89-393) **On determining distributed base resistance of bipolar transistors by noise measurements with gated integrator.** Korytov, A.V. Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems. 1989. 7p. (In Russian). Order Number DE90634245. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

Small value of distributed base resistance r is one of the demands for a head bipolar transistor of a low noise preamplifier. Thus, the choice of transistor type (since typical values of r are not specified in reference books) and specimen rejection require a simple method of r measurements. It is shown that distributed base resistance may be determined by simple noise measurements with a gated integrator. The r values for transistors KT 3101A-2 (r=8.4 Ohm), KT 391A-2 (r=14 Ohm), KT 3102B (r=190 Ohm) are determined. 10 refs.; 5 figs.

41503 (JINR-R–10-89-454) **Microprocessor system for temperature regulation and stabilization.** Nguyen Nhi Dien; Rodionov, K.G. Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Neutron Physics. 1989. 6p. (In Russian). Order Number DE90634244. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

Microprocessor based system for temperature regulation and stabilization of an operation external object is described. The system has the direct current amplifier working according to modulator-demodulator principle. The overal gain is 100, 1000, 2000. The maximum output signal is ±10 V. The power amplifier is a thyristor one and its line voltage is 220 V, 50 Hz. The output power is 0-2 kVA. The microcontroller has a remote display terminal. Data input is 8 and data output is one. Input and output voltage is ±(0-10) V. The preselection time for stabilization is within 1 s - 18 h. The program algorithm is given. 5 figs.; 1 tab.

41504 (LBL–29040) **Rheometer strain and strain-rate errors.** Giles, D.W.; Denn, M.M. Lawrence Berkeley Lab., CA (USA). May 1990. 4p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00098. (CONF-9009209–1: Golden jubilee meeting of the British society of rheology and 3. European rheology conference, Edinburgh (UK), 3-7 Sep 1990). Order Number DE90013845. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

We have found systematic errors which can affect measured rheological properties in the instrumentation of two commercial rheometers. Users of commercial instrumentation should establish the extent to which these and similar errors may exist in their systems. 2 refs., 1 fig.

41505 (MLM–3642(OP)) **Mass spectrometric analysis of hydrogen isotopes in metals and metal hydrides.** Ellefson, R.E. EG and G Mound Applied Technologies, Miamisburg, OH (USA). [1990]. 3p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-88DP43495. (CONF-9006241–1: 38. ASMS conference on mass spectrometry and allied topics, Tucson, AZ (USA), 4-8 Jun 1990). Order Number DE90014118. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

This paper discusses methods of measuring the quantity of hydrogen present in metals or metal hydrides using mass spectrometers. 6 figs. (FSD)

45 MILITARY TECHNOLOGY, WEAPONRY, AND NATIONAL DEFENSE

Refer also to citation(s) 40739

41506 (AD-A–220741/3/XAB) **Strategic planning for national security: Lessons from business experience. Interim report.** Bracken, P. Rand Corp., Santa Monica, CA (USA). Feb 1990. 37p. (RAND/N–3005-DAG/USDP). Available from NTIS, PC A03/MF A01.

United States defense planning is at a crossroads and it is therefore useful to review not only discrete issues, but even basic concepts of strategic planning. This Note reviews concepts used in the business world to build insights about how to view current and prospective problems, opportunities, and choices. The author draws upon the business literature for both ideas and metaphors. He observes that U.S. national security planning could profit greatly from an approach that distinguishes among core, environmental, and hedging strategies, and that considers security analogs to such business concepts as defining the business, dealing with new competitors, controlling the intensity of competition, entry and exit barriers, and the need to redeploy assets and restructure the organization. He then relates these concepts to specific problems of national security interest.

41507 (UCRL-JC–103714) **Progress toward steady-state, high-efficiency vircators.** Poulsen, P.; Chase, J.; Morrison, J.; Pincosy, P. Lawrence Livermore National Lab., CA (USA). 31 May 1990. 6p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-9006179–3: 5. national conference on high-power microwave technology, West Point, NY (USA), 10-15 Jun 1990). Order Number DE90013289. Available from NTIS, PC A02/MF A01 - OSTI.

The progress report toward high efficiency, long pulse operation of virtual cathode oscillators is described. The conditions for the resonance at which high efficiency is obtained are that the beam frequency equals the reflex frequency to within two percent. This implies that cathode closure in the anode-cathode gap is not acceptable. We have therefore developed and tested a cathode that will operate at 300 amps/cm^2 without significant closure for times in excess of one microsecond. 9 refs., 7 figs.

4501 Chemical Explosions and Explosives

Refer also to citation(s) 41004

41508 (DOE/AL/58309–45) **Preliminary investigation into the explosion potential of volatile organic compounds in WIPP [Waste Isolation Pilot Plant] CH-TRU [contact-handled–transuranic] waste.** Silva, M.K. Environmental Evaluation Group, Albuquerque, NM (USA); Environmental Evaluation Group, Carlsbad, NM (USA). Jun 1990. 49p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-89AL58309. (EEG–45). Order Number DE90014367. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The US EPA conducted hearings for the DOE's No-Migration Variance Petition. At the May 29, 1990 hearing in Santa Fe, a memo was cited as raising serious concerns about possibility of an explosion at WIPP caused by volatile organic compounds in the waste. Acetone and alcohols were identified as the potentially dangerous components. This report focuses on determining if volatile, flammable organic compounds such as acetone will be in the waste in sufficient quantities to represent a credible risk of explosion. This report examines the potential for an explosion from the non-radioactive components in the waste that can be sent to WIPP and the known flammable or explosive nature of any of those components or other combustible components that would be generated. 26 refs., 3 tabs.

41509 (LA-UR–90-2043) **Adaptation of an industrial application for an instructional laboratory in mechanical vibrations.** Whiteman, W.E. (Military Academy, West Point, NY (USA)). Los Alamos National Lab., NM (USA). [1990]. 4p. Sponsored by U.S. Department of Defense. DOE Contract W-7405-ENG-36. (CONF-9006175–2: Meeting of the American Society for Engineering Education, Toronto (Canada), Jun 1990). Order Number DE90013692. Available from NTIS, PC A02/MF A01 - OSTI.

Extensive theoretical treatment is given to damping as the process of energy dissipation during mechanical vibration. The challenge in the classroom is to adequately convey this concept and extend it by teaching students practical applications in engineering analysis and design. Students are motivated by real-world problems; applying these types of problems with strong instructional classroom content significantly enhances the learning environment. This paper proposes the adaptation of an actual research project to a simple, yet innovative, mechanical vibrations laboratory. The adapted project involves an ongoing effort at the Los Alamos National Laboratory to investigate damping factors of various alloys used in military tank munitions. The kinetic-energy penetrators used in these tank rounds are cylindrical in shape and are a major class of weapons designed to defeat heavy armor. Unwanted transverse oscillations of these penetrators degrade the accuracy of the rounds and may lead to glancing blows off the target. 5 refs., 3 figs.

41510 (MLM–3637) **Maximum credible event determination for the 3E1 detonator and its handling container.** Jones, R.B.; Cogan, J.D. Jr. EG and G Mound Applied Technologies, Miamisburg, OH (USA). 25 Jun 1990. 48p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-88DP43495. Order Number DE90013619. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

An investigation was conducted to determine the maximum credible event (MCE) value for the 3E1 detonator when packaged and handled, stored, or transported at Mound. A propagation test was performed to determine whether the detonation of one 3E1 detonator would detonate other like detonators. No propagation was noted. The MCE value for the 3E1 detonator in the handling tray was 0.37 g. When the tray is placed in a metal container, this value will be 0.000 g. 20 figs.

41511 (SAND–90-0694) **TI/PETN [titanium/pentaerythritol tetranitrate] accident investigation: Final report.** Ingersoll, D.; Andrzejewski, W.J.; Mitchell, D.E. Dotts, J.E. Sandia National Labs., Albuquerque, NM (USA). Jun 1990. 102p. Sponsored by U.S. DOE Environment Health & Safety. DOE Contract AC04-76DP00789. Order Number DE90013611. Available from NTIS, PC A06/MF A01 - OSTI; GPO Dep.

During a routine mixing operation, a 1:1 mixture of titanium and pentaerythritol tetranitrate (PETN) powders accidentally ignited. This prompted an investigation into the cause of the accident. Friction, impact, thermal, and electrostatic stimuli, as well as incompatibility between the powders, were evaluated for their potential to serve as the ignition mechanism. Although a definitive determination of the mechanism was not made, the operation that is believed to have imparted the requisite energy to cause ignition has been identified. The results of these studies, as well as recommended changes to the mixing operations, are described. 16 refs., 2 figs.

41512 (UCRL-JC–103218) **Parametric study of the dynamic JWL-EOS for detonation products.** Urtiew, P.A.; Hayes, B. Lawrence Livermore National Lab., CA (USA). Mar 1990. 25p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-9009183–1: 3. international Lavrentiev's readings conference, Novosibirsk (USSR), 10-14 Sep 1990). Order Number DE90013486. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The JWL equation of state describing the adiabatic expansion of detonation products is revisited to complete the description of the principal eigenvalue, to reset the secondary eigenvalue to produce a well-behaved adiabatic gamma profile, and to normalize the characteristic equation of state in terms of conventional parameters having a clear experimental interpretation. This is accomplished by interjecting a dynamic flow condition concerning the value of the relative specific volume when the particle velocity of the detonation

products is zero. In addition, a set of generic parameters based on the statistical distribution of the primary explosives making up the available data base is presented. Unlike theoretical and statistical mechanical models, the adiabatic gamma function for these materials is seen to have a positive initial slope in accord with experimental findings. 10 refs., 4 figs.

4502 Nuclear Explosions and Explosives

41513 (AD-A–220038/4/XAB) **Fusion of information from optical, thermal, multispectral imagery and geologic/topographic products to detect underground detonations. Phase 1. Final report.** Lucas, C. Autometric, Inc., Alexandria, VA (USA). 6 Mar 1990. 66p. (DF/P–1-90/519). Available from NTIS, PC A04/MF A01.

Original contains color plates: All DTIC and NTIS reproductions will be in black and white.

As the nuclear family of countries continues to expand, the need for close monitoring of worldwide test activities becomes an intriguing technical challenge. Phase I of this study focuses on those unclassified and classified imaging sensor products that can now, or may soon, be brought to bear on the monitoring problem in order to determine the feasibility of using such data to supplement or answer specific requirements. Since the products may be acquired on hardcopy (film) or softcopy (digital tapes), means to integrate them were investigated. This required that the digitizing of film and paper products be analyzed in terms of timeliness and fidelity as well as means to reproduce the derived digital results on high quality hardcopy. Several imaging sensor products were analyzed independently and jointly to document their unique characteristics and to assess their utility for supporting nuclear test monitoring. Those techniques that showed considerable promise were the precise superpositioning of data from multiple sources, the stereoscopic viewing of multiple mission and sensor products, and three-dimensional mapping of multiple image sets.

41514 (AD-A–220111/9/XAB) **Monte Carlo determination of gamma-ray exposure from a homogeneous ground plane. Master's thesis.** Howard, M.R. Air Force Inst. of Tech., Wright-Patterson AFB, OH (USA). School of Engineering. Mar 1990. 74p. (AFIT/GNE/ENP–90M-2). Available from NTIS, PC A04/MF A01.

The purpose of this study was to evaluate the gamma ray dose rate from an infinite homogeneous ground plane source of fission products from U-235, U-238, and Pu-239. In this study a Monte Carlo method was used to model the contribution to dose resulting from gamma scatter in the air and in the ground. This was accomplished by using the MORSE code. Two intermediate parameters which were used to determine the dose rate are the Source Conversion Coefficient (SCC) and Source Normalization Constant (K). The mono-energetic SCC was calculated from morse and then used to determine the time dependent SCC for a variety of spectra. Both the energy spectra and the gamma emission rates which were used in this study were determined by DKPOWR. The time dependent SCC's and K values are presented for the three fuels. The K values at one hour after burst were 8064 (rads-tissue/hr) (kt/sq km) for U-235 fission products, 8467 (rads-tissue/hr)/(kt/sq km) for U-238 fission products, and 7666 (rads-tissue/hr)/(kt/sq km) for Pu-239 fission products. The values of K as a function of time was compared to the WAY-Wigner approximation, t to the 1.2 power and found to differ by as much as 94% within 6 months. In addition to these results, the MORSE code was also used to compute a transport matrix which will permit the use of any other source spectrum and any other response function to be converted to a ground dose rate. This transport matrix is also presented.

41515 (AD-A–220117/6/XAB) **Modeling regional seismic waves from underground nuclear explosion. Final report, 17 March 1987-31 May 1989.** Clayton, R.W.; Harkrider, D.G.; Helmberger, D.V. California Inst. of Tech., Pasadena, CA (USA). Seismological Lab. 15 May 1989. 195p. Available from NTIS, PC A09/MF A02.

The research is divided into three main topics; modeling regional SH waves that propagate across lateral variations in structure, modeling explosions using 2-D numerical methods, and the effect of differing P and SV source time histories on the generation of Rayleigh and Love waves. Intermediate-period seismograms of earthquakes occurring along a profile to Imperial Valley are studied in terms of source phenomena versus path effects. Some of the events have known source parameters, determined by teleseismic or near-field studies, and are used as master events in a forward modeling exercise to derive the Green's functions (displacements at Pasadena due to a pure strike-slip or dip-slip mechanism) that describe the propagation effects along the profile. Both timing and waveforms of records are matched by synthetics calculated from two-dimensional velocity models. The effect of transition regions between continental and oceanic structure on the propagation of Lg waves from continental sources is examined. In particular, the attenuation due to variations in layer thickness in such transition regions is calculated and explained for a suite of simple models. Methods for representation theorem coupling of finite-element or finite difference calculations and propagator matrix method are demonstrated. The resulting hybrid technique can be used to study the propagation of any phase that can be represented in terms of SH mode sum seismogram, across regional transition zones or other heterogeneities.

41516 (AD-A–220152/3/XAB) **Feasibility of cross-validation as a parameter predictor for the iterative unfold method. Master's thesis.** Miller, D.J. Air Force Inst. of Tech., Wright-Patterson AFB, OH (USA). School of Engineering. Mar 1989. 121p. (AFIT/GNE/ENP–90M-5). Available from NTIS, PC A06/MF A01.

Different applications of the Fredholm integral equation appear in varied fields of study. An application of particular interest to the Air Force arises when attempting to determine pulsed radiation spectra using measured data from underground nuclear effects simulations. The iterative unfold technique provides a means for approximating a solution to a system of Fredholm integral equations. This method consists of modifying a guess spectrum through a fit process using data collected from experiment. Next, the unfolded spectrum is smoothed to reduce undesireable artifacts that result from the fitting process. Finally, the entire iterative process is then repeated as necessary to provide an approximation to the exact incident spectrum. Presently, the iterative unfold method lacks an independent measure of how well the unfolded spectrum approximates the exact spectrum. Consequently, user judgement is necessary, resulting in possible data overfitting. Cross-validation is a method which selectively partitions the measured data into subsets. The subsets of data are used to predict omitted data. A cross-validatory loss statistic can be formulated and minimized to predict the optimum stopping point for the iterative unfold process. The iterative unfold technique was implemented into a computer program.

41517 (AD-A–220154/9/XAB) **Large blast and thermal simulator reflected wave eliminator study. Final report, September 1986-September 1987.** Butz, J.; Kuna, M.; Guice, R.L.; Gottlieb, J.J. Dayton Univ., OH (USA). Research Inst. Mar 1990. 197p. Available from NTIS, PC A09/MF A02.

The design of a reflected wave eliminator (RWE) for the Large Blast/Thermal Simulator was investigated. Activities were divided into two categories, theoretical and computer modeled analysis, and conceptual design of RWE candidate configurations. The design effort was concentrated on active REWs where the open area changes over the time of the blast wave simulation. The computer analysis served to determine the rate of these area changes. Three different concepts were evaluated for the design of an active RWE. Stresses were analyzed and the power requirements to properly move the RWE during the passage of the blast wave were estimated. Two louver concepts were found to be lighter weight and more easily moved than a radial fan concept. A rotating louver design was recommended for further study. In addition, vents in the side wall of the LB/TS near the RWE were recommended in order to provide the maximum open area needed.

41518 (BARC–1475) **Autoregressive feature extraction for seismic source identification.** Roy, Falguni (Bhabha Atomic Research Centre, Bombay (India). Seismology Section). Bhabha Atomic Research Centre, Bombay (India). 1989. 34p. Order Number DE90633967. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

A prediction error filter (PEF) of a given order as computed from a P signal is almost identical to one computed from a composite signal comprising P and several reflected and refracted P phases.

Thus the PEF, in a way, represents the basic source function convolved with mantle and seismograph functions. For a given site and a recording station, the mantle and the seismograph functions will be constant. Therefore PEF as computed from signals which emanated from the given site and recorded at the given station will be mainly governed by the source functions. As the source functions of an earthquake and an explosion for a given body wave magnitude differ considerably, it is expected that these differences will be reflected in the corresponding prediction error filters. Degree of similarity or dissimilarity among these prediction error filters may then be utilized gainfully for the discrimination of the events. The effectiveness of the method has been demonstrated by analysing some synthetic seismograms and subsequently subjecting 22 actual seismograms comprising 10 presumed explosion signals and 12 earthquake signals to this method. The events analysed fall in the magnitude range 4.7 to 6.2. (author). 29 refs., 5 figs.

4503 Nuclear Explosion Detection

Refer also to citation(s) 42266

4504 Nuclear and Radiological Warfare

41519 (AD-A-219869/5/XAB) **Nuclear and NBC contamination survivability of medical materiel. Information report.** Comer, K.A.; Wright, W.P.; Zajac, A.J. Army Medical Materiel Development Agency, Fort Detrick, MD (USA). Mar 1990. 164p. Available from NTIS, PC A08/MF A01.

This paper provides military personnel and contractors involved in the development and acquisition of military equipment with background information pertaining to Nuclear, Biological, and Chemical (NBC) contamination survivability. Two categories of threat environments identified as Nuclear Weapons Effects (NWE) and NBC contamination are thoroughly described as well as the NBC terminology, protective measures, engineering practices, and organizational responsibilities that must be considered during materiel acquisition. The content in this paper was consolidated from the vast number of military standards (MIL-STDs), data item descriptions (DIDs), Army regulations (ARs), Quadripartite Standardization Agreements (QSTAGs) and other military documents that concern nuclear and NBC contamination and survivability as well as the input of the U.S. Army Nuclear and Chemical Agency, U.S. Army Laboratory Command and the U.S. Army Chemical Research, Development, and Engineering Center.

4505 Strategic Defense Initiative

Refer also to citation(s) 40962, 40964, 41816, 42265

41520 (AD-A-220131/7/XAB) **Optimization of a compton scatterer for hard x-ray weapons effects simulation in an ICF facility. Master's thesis.** Tinsley, R.L. Air Force Inst. of Tech., Wright-Patterson AFB, OH (USA). School of Engineering. Mar 1990. 65p. (AFIT/GNE/ENP-90M-7). Available from NTIS, PC A04/MF A01.

This thesis examined the optimization of a Compton scatterer for use in simulating hard X-ray effects in the proposed Laboratory Microfusion Facility (LMF). The LMF will produce inertial confinement fusion of deuterium-tritium pellets. The Compton scatterer is designed to reflect the X rays produced from the fusion toward a target. The scatterer should produce the maximum X-ray dose at the target while minimizing the neutron dose and gamma production. The scatterer must also control the dose rate by spreading the X-ray pulse to achieve a full width at half maximum on the order of 10s of ns. The current geometry includes a spherical Compton scatterer made of lithium hydride enriched to 95.6% Lithium 6. This work explored various parabolic scatterers using Monte Carlo transport calculations performed on the MCNP computer program from Los Alamos National Lab. The parabolic shape was optimized to increased the X-ray dose at a silicone target by a factor of 7. The geometry also decreased the neutron and gamma doses to less than 1% of the X-ray dose while achieving an 80% uniformity of dose across a 1-meter-radius silicon disk.

4506 Chemical and Biological

Refer also to citation(s) 41519

41521 (AD-A-220568/0/XAB) **Methods for demolition of building E5625. Contractor report, September 1987-November 1988.** Carpenter, T.J.; Hill, T.E.; Buchi, K.M. Battelle Columbus Labs., OH (USA). Mar 1990. 204p. Available from NTIS, PC A10/MF A02.

The U.S. Army Chemical Research, Development and Engineering Center (CRDEC) plans to dismantle and demolish the Pilot Plant (Building E5625). Now obsolete, this building was used to conduct chemical warfare (CW) agent studies. The objective of this program was to study and develop the best methods to safely demolish Building E5625. Aspects of the demolition considered included: environmental and personnel safety, applicable demolition techniques, debris disposal, and time and cost considerations. Five developed concepts were composed of combinations of the following major tasks: plan generation, site preparation, enclosing Building E5625 within a metal building, building demolition (selective or gantry crane/wrecking ball), hot gas decontamination of the entire building, decontamination of the building debris (chemical decontamination or incineration), and site closure.

54 ENVIRONMENTAL SCIENCES

5401 Environmental Sciences, Atmospheric

Refer also to citation(s) 40321, 40322, 40375, 40461, 40598, 40869, 40873, 40890, 40914, 40920, 40959, 41172, 41175, 41176, 41179, 41180, 41222, 41591, 41624, 41628, 41629, 41630, 41631, 41644, 41653, 41661, 41663, 41708, 41709, 41717, 41759

41522 (AD-A-220124/2/XAB) **Evaluation of three passive-integrating charcoal detectors for measuring radon concentrations. Master's thesis.** Sharp, D.L. Air Force Inst. of Tech., Wright-Patterson AFB, OH (USA). School of Engineering. Mar 1990. 72p. (AFIT/GNE/ENDP-90M-6). Available from NTIS, PC A04/MF A01.

Three types of passive-integrating detectors that determine Radon-222 (Radon) concentrations in air samples were studied. Each detector type examined uses activated charcoal to adsorb radon from air samples that enter through a diffusion barrier. This results in a time-integrated sample. The three detector types analyzed were liquid-scintillation vials and canisters with and without moisture-absorbing desiccant. The LS vials contain a mixture of charcoal and desiccant. All three types of detectors were calibrated in a chamber of known radon concentration. Since the LS vials had not previously been studied at AFIT, the optimum procedure for exposing, processing, and counting the vials was established. An automated liquid-scintillation counter (LSC) was used for determining the radon levels of the LS vials. The variability in the radon concentrations computed by the LSC for repeated counting of a single vial was examined and was found to be between 1 and 4%. Reproducibility of radon adsorption by a group of vials exposed simultaneously was examined. Reproducibility values for a group of ten vials counted for 4 cycles had a standard error of 1.4%. A blind test was performed where the detectors were exposed to a known concentration, prepared, counted, and then the concentrations measured were compared to actual values. The measured values were within 0.2% to about 8% of the actual concentrations. Exposure times of 24 to 48 hours were recommended for the vials and 3 to 7 days for the canisters.

41523 (AD-A-220607/6/XAB) **Environmental degradation: implications for national security. Study report.** Schlegel, J.D. Army War Coll., Carlisle Barracks, PA (USA). 30 Mar 1990. 113p. Available from NTIS, PC A06/MF A01.

As the United States prepares to move into the 21st century, the threat of armed conflict between the United States and the Soviet Union appears to have receded into the realm of the improbable. At the same time, however, a new and perhaps more ominous threat is emerging to challenge the security of nations: environmental degradation. Burgeoning world populations and the quest

for industrial/economic development have begun seriously to erode the capability of the earth's environment to sustain itself. The phenomena of global warming, ozone depletion, deforestation, desertification and many forms of pollution are destroying the delicate life support systems upon which humanity depends for its very survival. National security, therefore, must be redefined and in this instance must be viewed in a context outside the traditional concept of military capability. This paper examines economic, social, political and military implications of environmental degradation as threats to the security of the United States and to world security. The paper concludes that a new level of international cooperation and technological innovation are required to reduce the negative impact of environmental degradation. An appendix provides additional data on specific forms of environmental degradation.

41524 (AD-A-220833/8/XAB) **Strong decline near Boston of solar aureole brightness and column load of giant aerosols.** Volz, F.E. Air Force Geophysics Lab., Hanscom AFB, MA (USA). 1990. 16p. (GL-TR-90-0070). Available from NTIS, PC A03/MF A01.

Pub. in Applied Optics, Vol. 29(1990).

Large airborne particles, up to 100 microns in size, which originate from industry and transportation and especially from roads and highways, can nearly always be detected at the edge of the sun's disk due to their strong forward scattering. During May and June, airborne pollen make aureoles sometimes significantly brighter (and colored). In the balance between production, dispersal by turbulence, and fallout, brightness generally increases significantly during the day. By measurably suppressing the glare, it was found, in observations since 1974, that the average brightness, and therefore the column load of giant aerosols, gradually decreased to about one tenth of that in 1979. This is about 8 times faster than reduction in central and eastern sites of pollution measures – about 4% per year – related to small-sized haze and smoke. A corresponding, yet small effect can be deduced from high-volume aerosol collections from urban areas in two size ranges. Had those 24-hour and all-weather collections been made in daytime and fair weather only, the results might have confirmed ours more quantitatively.

41525 (AD-A-220877/5/XAB) **Volatilization of selected organic compounds from a creosote-waste land-treatment facility. Master's thesis.** Scott, E.J. Air Force Inst. of Tech., Wright-Patterson AFB, OH (USA). 1989. 97p. (AFIT/CI/CIA-90-011). Available from NTIS, PC A05/MF A01.

The purpose of this research was to evaluate the emissions of volatile and semi-volatile compounds which are constituents of a complex creosote waste from laboratory simulations of a land treatment system to assess the potential human exposure to hazardous compounds from this source. In addition, the Thibodeaux-Hwang Air Emission Release Rate (AERR) model was evaluated for its use in predicting emission rates of hazardous constituents of creosote wood preservative waste from land treatment facilities. A group of hazardous volatile and semi-volatile constituents present in the creosote waste was selected for evaluation in this study and included a variety of polynuclear aromatic hydrocarbons (PNA's), phenol, and chlorinated and substituted phenols.

41526 (BNL-43549) **Simultaneous determination of optical and thermodynamic properties of an evaporating aqueous solution droplet.** Tang, I.N.; Munkelwitz, H.R. Brookhaven National Lab., Upton, NY (USA). Apr 1990. 5p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76CH00016. (CONF-9009136-1: 3. international aerosol conference, Kyoto (Japan), 24-27 Sep 1990). Order Number DE90010652. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Advances in the single-particle levitation technique have made it possible to investigate evaporation of an aqueous solution droplet under controlled humidity conditions. The technique involves the levitation of a charged micron-sized inorganic salt particle in a quadrupole cell, which can be evacuated to $\sim 10^{-7}$ torr and back filled with water vapor to a predetermined pressure at a fixed temperature. Water evaporation occurs as the cell is evacuated slowly through a precision leak valve. Droplet mass change is measured by the dc voltage needed to counterbalance gravity, whereas the droplet size is continuously monitored by the 90°-angle laser light scattering. By fitting the light scattering data with Mie computations using appropriate refractive index and density estimates, it is possible to obtain these optical and thermodynamic properties over a wide concentration range from high dilution to high supersaturation. Such a wide concentration range can only be achieved with a suspended solution droplet. Results are presented for aqueous ammonium sulfate solution droplets. 4 refs., 4 figs.

41527 (CONF-8910337-2) **Application of artificial rain in experimental systems: Methods, results of case studies, and future needs.** Hanson, P.J.; McLaughlin, S.B.; Garten, C.T. Jr. Oak Ridge National Lab., TN (USA). [1989]. 11p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. From Conference on environmental research with plants in closed chambers; Munich (Germany, F.R.); 9-11 Oct 1989. Order Number DE90013382. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

Research have employed artificial rain systems ranging in complexity from simple dippers or hoses for irrigation purposes to complex machines capable of simulating the physical features of rainfall for many years. Variable water supplies leading to drought, flooding, and associated soil erosion were concerns that prompted the designs of these early attempts to simulate rainfall. With the recognition that precipitation was a source of contaminants which might impact the status of plant, soil, and water based systems. Further interest was generated in the creation of techniques for producing artificial rain that more appropriately simulated the physical and chemical interactions between rainfall and plant/soil systems. The objectives of this paper are to outline key features of existing rain simulation systems and to provide examples of these systems from the literature. In addition, we will summarize key results of recent research showing the impact of rain chemistry on foliar ion balance and physiology to give the reader an appreciation of the direct effects rainfall can have on foliar processes. 56 refs. 1 figs., 2 tabs.

41528 (CONF-9006232-1) **Equity and equality in the greenhouse.** Streets, D.G. Argonne National Lab., IL (USA). [1990]. 8p. Sponsored by U.S. DOE Energy Research. DOE Contract W-31109-ENG-38. From International workshop on assessing winners and losers in the contex of global warming; St. Julians (Malta); 18-21 Jun 1990. Order Number DE90013658. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

This paper discusses some ideas of how to balance equity and equality in negotiating action on greenhouse gases. Some parallels are drawn with previous agreements to combat another regional air pollution problem, acid rain. The ease with which formulations come into the mind should not mislead the reader into thinking the process will be easy. Setting international environmental policy is a tortuous process. Many attractive regulatory concepts, such as efficiency, cost-effectiveness, and benefits of control, are sacrificed on the negotiating table. But when the parties at the table represent such a broad cross-section of the human condition, some fundamental rethinking of cooperation and coordination is necessary. 8 refs.

41529 (CONF-9008126-1) **Numerical studies of the role of clouds in the present climate.** Randall, D.A. Colorado State Univ., Fort Collins, CO (USA). Dept. of Atmospheric Science. Aug 1990. 13p. Sponsored by U.S. DOE Energy Research; National Aeronautics and Space Administration. DOE Contract FG02-89ER69027. Grant NAT 5-1058. From Beijing international symposium on climate change; Beijing (China); 9-12 Aug 1990. Order Number DE90014345. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Until recently there has been lingering skepticism, in the general circulation modeling community, that the radiative effects of clouds significantly influence the atmospheric general circulation. Zonally uniform "observed" cloud amounts were, in some cases, prescribed by modelers who preferred to avoid confronting the complex physics of cloud formation. Ironically, GCMs have provided the proof that the radiative effects of clouds are important for the general circulation of the atmosphere. An important concept in analysis of the effects of clouds on climate is the cloud radiative forcing, which is defined as the difference between the radiative flux which

actually occurs in the presence of clouds, and that which would occur if the clouds were removed but the atmospheric state were otherwise unchanged. We also use the term CRF to denote warming or cooling tendencies due to cloud-radiation interactions. Cloud feedback is the change in CRF that accompanies a climate change. It is useful to distinguish among three aspects of the CRF: the "planetary CRF" acting at the top of the atmosphere, the "surface CRF" at the Earth's surface, and the "atmospheric CRF," which acts on the atmospheric itself and is the difference between the planetary and surface CRFs. This paper reviews the magnitudes, distribution causes, and consequences of the CRF, as they relate to climate modeling. A review of some earlier studies is combined with a brief presentation of new, previously unpublished results. 15 refs., 6 figs.

41530 (CONF-9008126–2) **Cloud parameterization for climate models.** Randall, D.A. Colorado State Univ., Fort Collins, CO (USA). Dept. of Atmospheric Science. Aug 1990. 36p. Sponsored by U.S. DOE Energy Research; National Aeronautics and Space Administration. DOE Contract FG02-89ER69027. Grant NAG 5-1058;Grant NAG 1-893. From Beijing international symposium on climate change; Beijing (China); 9-12 Aug 1990. Order Number DE90014344. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This paper presents a review of the problem of cloud parameterization for climate models, with equal attention to the radiative, convective, and latent effects of the clouds. The Colorado State University General Circulation Model is used as an illustrative example. The radiative effects are highly variable, depending on the cloud morphology and the level at which the cloud occurs. Microphysical effects may also be important. Small-scale mass circulations associated with clouds are of great importance for vertical energy transports, and also for carrying moisture to the middle and upper troposphere. Condensation and evaporation associated with clouds are due to both cumulus convection and large-scale saturation. These two processes are intimately linked, especially for upper tropospheric clouds. 61 refs., 16 figs.

41531 (DOE/ER/60290–4) **[Precipitation composition at Charlottesville, VA MAP3S site: Analysis and interpretation of results]: Progress report.** Galloway, J.N. Virginia Univ., Charlottesville, VA (USA). Dept. of Environmental Sciences. [1990]. 13p. Sponsored by U.S. DOE Energy Research. DOE Contract FG05-85ER60290. Order Number DE90014351. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This document contains information on the progress of the "Precipitation Composition at Charlottesville, VA MAP3S Site" project. Topics discussed include processes that control the composition of the precipitation, impact of microbial communities an precipitation composition, the cycling of carboxylic acids, atmospheric transport of terrestrial material, anthropogenic versus natural influences in precipitation chemistry, organic nitrogen compounds, data generation and interpretation and other related activities. 4 figs. (KJD)

41532 (DOE/ER/69027–T1) **The role of clouds in CO_2-induced climate change: Technical progress report, September 1989–July 1990.** Randall, D.A. Colorado State Univ., Fort Collins, CO (USA). Dept. of Atmospheric Science. [1990]. 15p. Sponsored by U.S. DOE Energy Research. DOE Contract FG02-89ER69027. Order Number DE90014380. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This report discusses activities and accomplishments made from September 1989–July 1990 on "The Role of Clouds in CO_2-Induced Climate Change" project. This three-year project includes the following tasks: continue participation in the Department of Energy's General Circulation Model (GCM) Intercomparison Project, study the response of a one-dimensional coupled ocean-atmosphere model to changes in CO_2, analyze cloud forcing simulations with the CSU GCM by comparison with observations from ISCCP, FIRE, and ERBE, perform CO_2 sensitivity studies with a X-flux version of the CSU model, and begin a long-term project to couple the CSU model with a global ocean model, in preparation for more definitive CO_2 sensitivity studies.

41533 (IC–90/36) **Pyrheliometric determination of atmospheric turbidity in harmattan over Ile-Ife, Nigeria.** Adeyefa, Z.D. (Obafemi Awolowo Univ., Ile-Ife (Nigeria). Physics Dept.); Adedokun, J.A. International Centre for Theoretical Physics, Trieste (Italy). Feb 1990. 31p. Order Number DE90633625. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Measurements of direct solar radiation intensity, using an Angstrom compensation pyrheliometer carried out over three harmattan seasons (1985-1987) at Ile-Ife (7.29N, 4.34E) Nigeria, have been used to determine atmospheric turbidity based on five different models of turbidity, viz: Schuepp (B), Angstrom (β), Kastrov (C), Unsworth (τ_a) and Linke (T). The five parameters indicate high aerosol loading of the atmosphere during the period and high correlation is established between them: ($0.919 \leq \tau \leq 0.999$). An inverse relationship has been noticed between horizontal visibility and atmospheric turbidity: ($-0.80 \leq \tau \leq -0.76$). (author). 35 refs, 15 figs, 4 tabs.

41534 (Juel-Spez–522) **Statistical investigation concerning the limitation of short-term emissions of radioiodine.** Heinemann, K.; Brunen, E. Kernforschungsanlage Juelich GmbH (Germany, F.R.). Abt. Sicherheit und Strahlenschutz. Oct 1989. 29p. (In German). Order Number DE90510165. Available from NTIS (US Sales Only), PC A03/MF A01.

The study was to reveal the impact of ten short-term, enhanced emissions of radioiodine during a one-year period (1/200 of the annual emission on one day) on the annual radiation exposure of the environment. At first, the fluctuation of the long-term dispersion factors is shown on the basis of data covering a whole calendar year. Then the long-term dispersion factors are calculated by means of over lapping of the short-term dispersion factors with their azimutal dependance corresponding to the measured direction of dispersion at given points within a measuring network. The results thus obtained, taking into account a data basis covering a period of ten years, agree well with results calculated according to the general calculation model for assessment of radiation exposure due to radioactive effluents. For all calculations it is assumed that the annual emissions reach the maximum permissible annual limit. The times of release of enhanced short-term emissions (hours) are determined by a random number generator. The corresponding, measured dispersion conditions are introduced in the calculations. For purposes of statistical significance, 2.000 calculations are done for every year between 1974 and 1983, and for three effective emission altitudes of 50, 100, and 200 m. In the case of the two lower altitudes, no significant increase of radiation exposure (99-percentile) is revealed. Even with emissions at 200 m, the determined fluctuations of the maximum radiation exposures are within the scattering range of the meteorological or radioecological parameters applied for calculation of annual radiation doses. (orig./HP).

41535 (KFK–4604) **ISOLA V - a FORTRAN 77-code for the calculation of the long-term concentration distribution in the environment of nuclear installations.** Huebschmann, W. (Kernforschungszentrum Karlsruhe GmbH (Germany, F.R.). Inst. fuer Meteorologie und Klimaforschung); Raskob, W. Kernforschungszentrum Karlsruhe GmbH (Germany, F.R.). Inst. fuer Neutronenphysik und Reaktortechnik; Kernforschungszentrum Karlsruhe GmbH (Germany, F.R.). Projekt Nukleare Sicherheitsforschung. Apr 1990. 46p. Order Number DE90510167. Available from NTIS (US Sales Only), PC A03/MF A01.

The computer program ISOLA V has been developed to calculate the dispersion of radioactive material released with a constant rate into the atmosphere during a given time period from several days up to several months. It will be used as a subroutine in the program system UFOMOD for assessing the consequences of accidental releases of radionuclides into the environment. ISOLA V is a statistical Gaussian dispersion model. It calculates the activity concentration in air near the ground and the ground contamination due to dry and wet deposition at specified locations in a polar grid system. The program requires a four-parametric meteorological statistics derived from one or more years synoptic recordings of 1-hour-averages of wind speed, wind direction, stability class and pricipation intensity. (orig.).

41536 (LA-UR–90-1386) **Three-dimensional forecasting models on a desk-top computer.** Yamada, T.; Bunker, S. Los Alamos National Lab., NM (USA). [1990]. 13p. Sponsored by U.S.

Department of Defense. DOE Contract W-7405-ENG-36. (CONF-9009134–1: ENVIRONSOFT '90: 3. international conference, Montreal (Canada), 11-13 Sep 1990). Order Number DE90010612. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Recent advances in the desk-top computer capabilities, particularly those of an engineering workstation, are truly astonishing. A high performance workstation reportedly exceeded a supercomputer in certain scaler operations. Affordability and portability of a desk- top computer opened doors to many applications which were previously considered impossible. The purpose of the present study is to demonstrate the feasibility of using and engineering workstation to operate a three-dimensional mesoscale modeling system to describe the transport and dispersion of atmospheric pollutants over complex terrain surrounding Vandenberg Air Force Base (VAFB), Vandenberg, California. Our modeling system is composed of two numerical codes, HOTMAC, and RAPTAD. HOTMAC is a mesoscale forecast code that is able to model three-dimensional distributions of wind speed, wind direction, turbulence, temperature, and water vapor. RAPTAD is a Lagrangian puff code based on the Monte Carlo statistical diffusion process. RAPTAD can be used under extreme conditions where a conventional Gaussian plume model may fail.

41537 (ORNL/TM–10914) **Managing global climate change through international cooperation: Lessons from prior resource management efforts.** Feldman, D.L. Oak Ridge National Lab., TN (USA). Jul 1990. 53p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE90014699. Available from NTIS, PC A04/MF A01 - OSTI; GPO Dep.

This report addresses the availability of an incremental and iterative learning process for enhancing international cooperation in the management of global climate change. The process is iterative because carefully formulated agreements are replicated in increasingly larger and diverse contexts. Through an examination of three case studies concerning regional seas, ozone, and nuclear-materials regulation, models for global cooperation are identified that encompass concerns about the size and distribution of correction costs among countries, the uncertainties involved in identifying cause-effect relationships, the vulnerability of shared resources, and the divergent needs of developed and developing countries. The ability of these models to encompass such concerns comes from their emphasis on interactive learning among scientists, environmental groups, international organizations, and governments of nations. 120 refs., 4 tabs.

41538 (PB–90-187949/XAB) **National Radon Measurement Proficiency (RMP) Program: Cumulative proficiency report, January 1990.** Research Triangle Inst., Durham, NC (USA). Jan 1990. 382p. Available from NTIS, PC A17/MF A02.

See also PB–89-117634.

The report is a complete listing of participants who met EPA's National Radon Measurement Proficiency (RMP) Program requirements during Test Round 6 conducted March-December 1989. It is intended for use by Federal, State, and local officials, radon measurement companies, radon mitigation contractors, concerned homeowners, and other persons as an aid in selecting reliable sources of radon.

41539 (PB–90-195587/XAB) **Air quality criteria for carbon monoxide. Draft report.** Dodge, M.C.; Richter, H.G.; Altshuller, A.P.; Bufalini, J.J. Environmental Protection Agency, Research Triangle Park, NC (USA). Environmental Criteria and Assessment Office. Mar 1990. 733p. (ECAO-R–0073). Available from NTIS, PC A99/MF A04.

The revised air quality criteria document for carbon monoxide (CO) reviews and evaluates the scientific information on the health effects associated with exposure to the concentrations of CO found in ambient air. Although the document is not intended to be an exhaustive literature review, it is intended to cover all the pertinent literature through late 1989. The references cited in the document are, therefore, reflective of the current state of knowledge on those issues relevant to the subsequent review of the national ambient air quality standards (NAAQS) for CO, currently set at 9 ppm (10 mg/cu m) for 8 h and 35 ppm (40 mg/cu m) for 1 h. Major gaps in knowledge also are identified. Although emphasis is placed on the presentation of health effects data, other scientific data are presented and evaluated in order to provide a better understanding of the nature, sources, distribution, measurement, and concentrations of CO in the environment, as well as the measurement of population exposure to CO.

41540 (PB–90-205477/XAB) **Climate change and America's forests. Forest Service general technical report.** Joyce, L.A.; Fosberg, M.A.; Comanor, J.M. Forest Service, Fort Collins, CO (USA). Rocky Mountain Forest and Range Experiment Station. Feb 1990. 18p. (FSGTR-RM–187). Available from NTIS, PC A03/MF A01.

Projections in the Forest Service Assessment assume a future in which changes in timber production and land use are not abrupt discontinuities from the past. These assumptions may not be met if the earth's climate changes rapidly. The document summarizes the current research on the impacts of climate change on America's Forests.

41541 (PB–90-207242/XAB) **AIRS Facility subsystem source classification codes and emission factor listing for criteria air pollutants. Final report, 1990-1991.** Environmental Protection Agency, Research Triangle Park, NC (USA). Office of Air Quality Planning and Standards. Mar 1990. 241p. (EPA–450/4-90/003). Available from NTIS, PC A11/MF A02.

The publication contains emission factors which may be used to estimate air pollution emissions from stationary point sources (such as industrial plants) for six criteria pollutants: PM10, sulfur oxides, nitrogen oxides, reactive volatile organic compounds, carbon monoxide and lead. Factors are grouped by source classification codes which are used by EPA to store and retrieve point source emission data. Each SCC represents a unique process or function within a source category logically associated with a point of air pollution emissions. The document also briefly explains how to calculate estimated point source emissions.

41542 (PB–90-207978/XAB) **PM-10 open fugitive dust source computer model package. User's manual.** Environmental Protection Agency, Research Triangle Park, NC (USA). Office of Air Quality Planning and Standards. Apr 1990. 37p. (EPA–450/3-90/010). Available from NTIS, PC A03/MF A01.

For system on diskette, see PB–90-502022.

The computer programs in the package are based on the material presented in the document, Control of Open Fugitive Dust Sources, EPA-450/3-88-008. The programs on these diskettes serve two purposes. Their primary purpose is to facilitate the process of data entry, allowing the user not only to enter and verify the data which he/she possesses, but also to access additional data which might not be readily available. The second purpose is to calculate emission rates for the particular source category selected using the data previously entered and verified.

41543 (PB–90-208570/XAB) **Estimating the spatial variability of trace-gas deposition velocities. Technical memo.** McMillen, R.T. National Oceanic and Atmospheric Administration, Oak Ridge, TN (USA). Atmospheric Turbulence and Diffusion Lab. Mar 1990. 44p. (NOAA-TM-ERL–181). Available from NTIS, PC A03/MF A01.

Dry deposition of gaseous and particulate materials constitutes a significant fraction of the total acidic deposition. Dry deposition measurements are difficult to obtain and are usually available only for a single location. An understanding of the spatial variability of dry deposition is fundamental to extending site-specific measurements to subregional and regional scales. The study estimates the spatial variability of the dry deposition velocity over three 84 km by 84 km study areas by use of a deposition velocity model. Inputs to the model consist of meteorology, land use type, and terrain roughness. Meteorological data were available from an ongoing dry deposition research program; terrain and land use data were derived from U.S. Geological Survey (USGS) Digital Elevation Models and Landsat Thematic Mapper data, respectively. Model run results are presented for one month's data at one site and for 12 weekly averages at all three sites. Verification of the technique is presented, but only at a single point.

41544 (PB–90-208588/XAB) **Atmospheric methane data for the period 1983-1985 from the NOAA/GMCC global cooperative flask sampling network. Technical memo.** Lang, P.M.; Steele, L.P.; Martin, R.C.; Masarie, K.A. Colorado Univ., Boulder, CO (USA). Cooperative Inst. for Research in Environmental Sciences. Mar 1990. 97p. (NOAA-TM-ERL-CMDL–1). Available from NTIS, PC A05/MF A01.

The report presents details of relevant aspects of the NOAA/GMCC program to measure atmospheric methane concentrations through its global, cooperative, flask sampling network. These aspects include the history of the development of the program; details of the sampling network; the flasks and the flask sampling methods; the analytical instrumentation and methods; and the calibration gases and methods. The data from individual flask samples are tabulated, as are the monthly average methane concentrations. Through adequate documentation it is more likely that the full value of these methane measurements will be realized in long-term studies of the greenhouse effect and climate change.

41545 (PB–90-212200/XAB) **National Acid Precipitation Assessment Program (NAPAP) Emissions Inventory, 1985: Development of species allocation factors. Final report, January 1989-January 1990.** Walters, R.A.; Saeger, M.L. Alliance Technologies Corp., Chapel Hill, NC (USA). Apr 1990. 472p. Available from NTIS, PC A20/MF A03.

For system on magnetic tape, see PB–90-502097.

The report describes the methodologies and data bases used to develop species allocation factors and data processing software used to develop the 1985 National Acid Precipitation Assessment Program (NAPAP) Modelers Emissions Inventory (Version 2). Species allocation factors were developed to convert annual emissions estimates of hydrocarbons, nitrogen oxides (NOx), and total suspended particulates (TSP) into more resolved classes to be used in modeling and assessment activities. The factors were used to divide: the hydrocarbon estimates in the annual inventory into 32 representative chemical classes based on common reactivity and product species, the NOx estimates into NO and NO2, and the TSP estimates into 15 classes based on component species and size ranges. Temporal, spatial, and pollutant species allocation factors have been developed to convert annual emissions data into resolved modeling formats suitable for use as input to regional transport models such as the Regional Acid Deposition Model. The level of resolution required for the allocation factors was defined by the modelers based on analyses of model performance and emissions data bases.

41546 (PB–90-212572/XAB) **Acid Aerosol Measurement Workshop. Held in Research Triangle Park, North Carolina on February 1-3, 1989. Final report.** Wilson, W.E. Research and Evaluation Associates, Inc., Chapel Hill, NC (USA). 1989. 129p. Available from NTIS, PC A07/MF A01.

The report documents the discussion and results of the U.S. EPA Acid Aerosol Measurement Workshop, conducted February 1-3, 1989, in Research Triangle Park, North Carolina. It was held in response to recommendations by the Clean Air Scientific Advisory Committee (CASAC) regarding issues associated with the characterization of aerosol acidity and acid aerosol measurement methods. The workshop was structured to identify appropriate indicators and methodology for characterizing aerosol acidity and to develop ideas and recommendations for the evaluation of acid aerosol methods currently in use. The workshop participants identified the development of an accurate, reliable, and interference-free method as an important initial research objective, and concluded that the most appropriate indicator of aerosol acidity is fine-particle strong acidity measured as hydrogen ion by either pH or titration. After considering procedures to evaluate current acid aerosol measurement methods, workshop participants concluded that the evaluation process must include the development and distribution of audit standards to check the accuracy and precision, and both laboratory and field tests to evaluate and compare acid aerosol sampling and analysis systems. The report provides background on the CASAC recommendations and summarizes the presentations, discussions, conclusions, and recommendations at the workshop.

41547 (PB–90-212614/XAB) **Summary report for the National Atmospheric Deposition Program/National Trends Network (NADP/NTN) site visitation program for the period October 1987 through September 1988.** Eaton, W.C.; Moore, C.E.; Murdoch, R.W.; Shores, R.C.; Ward, D.A. Research Triangle Inst., Durham, NC (USA). Apr 1990. 88p. Available from NTIS, PC A05/MF A01.

The U.S. Environmental Protection Agency (EPA) provides technical assistance to the NADP/NTN network through a site visitation program. Research Triangle Institute, as contractor to EPA, conducts these visits. If deficiencies or nonstandard procedures are noted, the site operator and supervisor are notified. Brief reports are sent to the EPA Project Officer, the NADP/NTN Quality Assurance Manager, and others. In this way, necessary changes can be made promptly. All NADP.NTN sites were visited in 1985-1986. A second round of visits began in October 1986, with the goal of visiting approximately one-third of the 200 sites each year over the next three years. The document is a summary report of the findings from the 1987-1988 (Fiscal Year 1988) site visitation program to 57 of the sites of the NADP/NTN network. In its present configuration, the network's research and monitoring programs are supported and operated by the U.S. Geological Survey; State Agricultural Experiment Stations; the Departments of Agriculture, the Interior, Commerce, and Energy; and EPA. Additional support is provided by state agencies, public utilities, and industries.

41548 (PB–90-216078/XAB) **Modeling of particle formation and dynamics in a flame incinerator.** Sethi, V.; Biswas, P. Cincinnati Univ., OH (USA). Dept. of Civil and Environmental Engineering. ©1990. 8p. Available from NTIS, PC A02/MF A01.

Pub. in Jnl. of Air Waste Management Association 40, 42-46(Jan 1090).

The paper describes the development of a model to predict the formation and growth of metallic particles in a flame incinerator system. Flow fields and temperature profiles in a cylindrical laminar jet flame have been used to determine the position and physical conditions of the species along the flame. The size distribution of the particles formed was approximated by a unimodal lognormal function to describe aerosol behavior in the flame. The effects of inlet metallic vapor feed concentrations, initial seed sizes, and seed concentrations on the resultant particle size distribution are presented. The model has potential for further development to be used as a predictive technique for applications in design and operation of incinerator systems.

41549 (PB–90-216086/XAB) **Catalytic oxidation of 1,1-dichloroethane.** Ramanathan, K.; Spivey, J.J. Research Triangle Inst., Durham, NC (USA). ©1989. 11p. Available from NTIS, PC A03/MF A01.

Pub. in Combustion Science and Technology, Vol. 63, 247-255(1989).

The paper gives results of an investigation of the catalytic oxidation of 1,1-dichloroethane over a commercial Cr_2O_3/Al_2O_3 catalyst at 500 ppm and 30-500 C. Vinyl chloride was observed as an intermediate in the oxidation process, being formed to significant extents between 230 and 330 C. This suggests HC1 abstraction as the first step in the catalytic oxidation process. Similar experiments on 1,1,1-trichloroethane showed the presence of a 1,1-dichloroethylene intermediate, supporting the HC1 abstraction hypothesis. In both cases, no carbon-chloride bonds were left at 500 C. No significant CO formation was observed, with the material balance on carbon atoms being satisfied by CO_2 at 500 C.

41550 (PB–90-216094/XAB) **Principal component analysis of SO_4(2-) precipitation concentrations over the eastern United States.** Eder, B.K. Environmental Protection Agency, Research Triangle Park, NC (USA). Atmospheric Research and Exposure Assessment Lab. ©1989. 14p. (EPA–600/J-89/344). Available from NTIS, PC A03/MF A01.

Pub. in Atmospheric Environment, Vol. 23, No. 12, 2739-2750(1989).

The spatial and temporal variability of SO_4(-2) concentrations in precipitation over the eastern United States during the period 1981-1986 was examined through the use of principal component analysis. Application of Kaiser's Varimax orthogonal rotation led to the delineation of seven contiguous subregions, each displaying statistically unique SO_4(-2) concentration characteristics. These seven statistically significant modes of variability, which together

accounted for 74.2% of the total variance, corresponded well with major SOx emission patterns. Examination of the time series associated with subregion revealed a general seasonality in which periods of high concentrations are more likely during the summer, while periods of low concentrations are more likely during the winter. This seasonal cycle, however, was more prevalent in those subregions which contained few major emissions, and was less prevalent and often obscured by perturbations in those subregions which contained major emissions.

41551 (PB–90-216102/XAB) **Evaluation of long-term sulfur deposition models.** Clark, T.L.; Voldner, E.C.; Dennis, R.L.; Seilkop, S.K.; Alvo, M. Environmental Protection Agency, Research Triangle Park, NC (USA). Atmospheric Sciences Research Lab. ©1989. 24p. (EPA–600/J-89/345). Available from NTIS, PC A03/MF A01.

Pub. in Atmospheric Environment, Vol. 23, No. 10, 2267-2288(1989).

The International Sulfur Deposition Model Evaluation (ISDME) project, jointly conducted by the U.S. Environmental Protection Agency and Atmospheric Environment Service of Environment Canada, assessed the performance of eleven linear chemistry atmospheric models in predicting amounts of sulfur wet deposition. Standardized model input data sets were distributed to the participating modelers, who later submitted seasonal and annual 1980 model predictions of dry/wet deposition and air concentrations of sulfur dioxide and sulfate at up to 66 sites across eastern North America. The models were evaluated in an operational mode using new, more rigorous approaches, as well as the more conventional distribution statistics recommended by the American Meteorological Society. The new approaches focused on the ability of the models to replicate features of the spatial patterns of sulfur wet deposition, as determined by an interpolation technique known as kriging. The technique quantified the uncertainties in the observations which were used in the evaluation process to identify areas where interpolated predictions were statistically significantly different from the interpolated observations. To supplement the evaluation, predictions of dry deposition amounts and air concentrations of each model were intercompared to identify apparent peculiarities. Finally, a scoring system based on criteria for six model performance measures was devised to compare seasonal, annual and overall performances of the models. Three clusters of models, each with similar overall scores, were identified.

41552 (PB–90-216342/XAB) **Comparison of indices that describe the relationship between exposure to ozone and reduction in the yield of agricultural crops.** Lefohn, A.S.; Laurence, J.A.; Kohut, R.J. Boyce Thompson Inst. for Plant Research, Ithaca, NY (USA). ©1988. 14p. Available from NTIS, PC A03/MF A01.

Pub. in Atmospheric Environment, Vol. 22, No. 6, 1229-1240(1988).

The objective of the study is to compare the use of several indices of exposure in describing the relationship between O_3 and reduction in agricultural crop yield. No attempt has been made to determine which exposure-response models best fit the data sets examined. Hourly mean O_3 concentration data, based on two-three measurements per hour, were used to develop indices of exposure from soybean and winter wheat experiments conducted in open-top chambers at the Boyce Thompson Institute, Ithaca, NY NCLAN field site. The comparative efficacy of cumulative indices (i.e. number of occurrences equal to or above specific hourly mean concentrations, sum of all hourly mean concentrations equal to or above a selected level, and the weighted sum of all hourly mean concentrations) and means calculated over an experimental period to describe the relationship between exposure to O_3 and reductions in the yield of agricultural crops was evaluated. None of the exposure indices consistently provided a best fit with the Weibull and linear models tested. The selection of the model appears to be important in determining the indices that best describe the relationship between exposure and response.

41553 (PB–90-216409/XAB) **Measurement of organic compound emissions using small test chambers.** Tichenor, B.A. Environmental Protection Agency, Research Triangle Park, NC (USA). Air and Energy Engineering Research Lab. ©1989. 10p. (EPA–600/J-89/328). Available from NTIS, PC A02/MF A01.

Pub. in Environment International, Vol. 15, 389-396(1989).

The paper discusses the measurement of organic emissions from a variety of indoor materials, using small (166 liter) environmental test chambers. The following materials were tested: adhesives, caulks, pressed wood products, floor waxes, paints, and solid insecticides. For each material, chamber concentration of organics has been determined for a range of environmental conditions (e.g., air exchange rate, temperature, and relative humidity). Various product loading ratios (area of sample/volume of chamber) have also been investigated. Emission rates for individual organic compounds, as well as total measured organics, were calculated. The effects of environmental variables on emission rates have been evaluated. Models are used to evaluate the effect of chamber walls and concentration on emission rates.

41554 (PB–90-216433/XAB) **Emissions and cost estimates for globally significant anthropogenic combustion sources of NOx, N_2O, CH_4, CO, and CO_2. Final report, April 1987-January 1990.** Piccot, S.D.; Buzun, J.A.; Frey, H.C. Radian Corp., Research Triangle Park, NC (USA). May 1990. 125p. Available from NTIS, PC A06/MF A01.

The report discusses the development of emission factors for CO_2, CO, CH_4, NOx, and N_2O for about 80 globally significant combustion sources in seven source categories: utility, industrial, fuel production, transportation, residential, commercial, and kilns/ovens/dryers. Because of the lack of adequate international data, the emission factors for most sources are based on U.S. performance, cost, and emissions data. Data on CO_2, CO, and NOx were available for over 90% of the sources studied: on CH_4, for about 80%; and on N_2O, for only about 10%. Emission factor quality ratings were developed to indicate the overall adequacy of the supporting data. Evaluation of the emission factors for the seven source categories (taking the five gases as an aggregate for each category) showed that the kilns/ovens/dryers category had the lowest overall quality rating.

41555 (PB–90-216532/XAB) **Assessment of VOC emissions from fiberglass-boat manufacturing. Final report.** Stockton, M.B.; Kuo, I.R. Radian Corp., Research Triangle Park, NC (USA). May 1990. 101p. Available from NTIS, PC A06/MF A01.

The report presents an assessment of volatile organic compound (VOC) emissions from fiberglass boat manufacturing. A description of the industry structures is presented, including estimates of the number of facilities, their size, and geographic distribution. The fiberglass boat manufacturing process is described, along with sources and types of VOC emissions. Model plants representative of typical facilities are also described. Estimates of VOC emissions are presented on per plant and national bases. VOC emissions from this industry consist mainly of styrene emission from gel coating and lamination, and acetone or other solvent emissions from clean-up activities. Finally, potential VOC control technologies are evaluated for this industry, including a discussion of technical feasibility. Limited cost data are also presented.

41556 (PB–90-217084/XAB) **Guide for determining compliance with the Clean Air Act standards for radionuclide emissions from NRC-licensed and non-DOE federal facilities. (Revision 1).** Office of Radiation Programs, Washington, DC (USA). Oct 1990. 70p. (EPA–520/1-89/002). Available from NTIS, PC A04/MF A01.

The report provides guidance for determining compliance with one of the National Emission Standards for Hazardous Air Pollutants (NESHAPs) covering facilities not operated by the DOE, that could emit radionuclides to the air. (40 CFR 61, Subpart 1).

41557 (PB–90-218611/XAB) **Portable instruments user's manual for monitoring VOC sources.** Busik, J.; Cunningham, M. PEI Associates, Inc., Cincinnati, OH (USA). Jun 1986. 144p. Available from NTIS, PC A07/MF A01.

The U.S. Environmental Protection Agency (EPA) has promulgated New Source Performance Standards (NSPS) and National Emission Standards for Hazardous Air Pollutants (NESHAP's) for several categories of sources that emit volatile organic compounds

(VOC's) and that require monitoring with portable detection instruments. The manual presents information on the principles of operation of currently available portable monitors and the field inspection techniques for the monitor's safe use in both screening and compliance determinations. The manual is intended to be used by State and local agencies. The level of the inspection performed is often determined by the compliance history of the source and the regulatory requirements. The EPA has published Reference Method 21 to provide a technical method to test for leaks from these sources. Method 21 allows the user to select one of several instruments available on the market if they meet the specifications and performance requirements, discussed in Section 2. A summary of the published specifications of many of the portable VOC monitors is presented in the manual.

41558 (PB–90-219163/XAB) **Quality-assurance guidelines for transmission-electron-microscopy asbestos laboratories.** Chesson, J.; Chatfield, E.; Rench, J.; Berner, T. Chesson Consulting, Washington, DC (USA). Dec 1989. 66p. Available from NTIS, PC A04/MF A01.

Guidance is provided for refining quality assurance programs for transmission electron microscopy asbestos laboratories. Emphasis is provided for interpreting quality assurance data and controlling laboratory contamination problems.

41559 (PB–90-219726/XAB) **Destruction of volatile organic compounds using catalytic oxidation.** Kosusko, M.; Nunez, C.M. Environmental Protection Agency, Research Triangle Park, NC (USA). Air and Energy Engineering Research Lab. ©1990. 9p. (EPA–600/J-90/025). Available from NTIS, PC A02/MF A01.

Pub. in Jnl. of Air Waste Management Association, Vol. 40, No. 2, 254-259(Feb 1990). See also PB–89-221261.

Catalytic oxidation is an air pollution control technique in which volatile organic compounds (VOCs) and vapor-phase air toxics in an air emission stream are oxidized with the help of a catalyst. Design of catalytic systems for control of point source emissions is based on stream-specific characteristics and desired control efficiency. The paper discusses the key emission stream characteristics and VOC characteristics that affect the applicability of catalytic oxidation. The application of catalytic oxidation technology to four types of air emission sources is discussed: (1) groundwater stripping operations; (2) graphic arts facilities; (3) flexographic printing plants; and (4) latex monomer production. The characteristics of each of these emissions are discussed along with the catalytic technology used to control these emissions.

41560 (PB–90-219759/XAB) **Compact coiled denuder for atmospheric sampling.** Pul, D.Y.H.; Lewis, C.W.; Tsai, C.J.; Liu, B.H. MSP Corp., Minneapolis, MN (USA). ©1990. 8p. Available from NTIS, PC A02/MF A01.

Pub. in Environmental Science and Technology, Vol. 24, No. 3, 307-312(1990).

A 10 slpm coiled denuder has been designed and experimentally characterized. Its geometrical parameters and operating characteristics are summarized in Table II. The gas collection efficiency for SO2 exceeds 99% and thus is comparable with annular denuder efficiencies. Experiment has shown that the particle loss is small for neutral particles in the size range 0.015-2.5 micro m. Particle loss measurements also indicate that the unit can operate equally well in any orientation. The short axial length (6 cm) of the coiled denuder has the advantage that a denuder train of multiple units in series will have a total length that is substantially less than a corresponding train of annular denuders.

41561 (PB–90-220211/XAB) **Toxic air pollutant inventory for the state of Illinois. Final report.** Kong, E.J.; Turner, J.H.; Reddy, K.R. Research Triangle Inst., Research Triangle Park, NC (USA). Center for Environmental Systems. Mar 1990. 114p. Available from NTIS, PC A06/MF A01.

The emission of toxic air pollutants (TAPs) creates potential or actual health problems for populations surrounding the emitting sources. Prior to estimating the health and environmental impacts associated with the toxic pollutant emissions, an emission inventory must exist for an interested planning and regulatory agency to understand emission patterns and trends and to help the agency focus on certain pollutants and emission sources in its detailed inventory. The Illinois Department of Energy and Natural Resources (ENR) has identified the need for a preliminary inventory of TAP emissions from industries and businesses within the State that could be used to define its air toxics problem, to identify potential control strategies, and to set priorities on subsequent data collection activities. The Research Triangle Institute (RTI) was contracted by ENR's Office of Research and Planning to establish such a preliminary emission inventory of TAPs and heavy metals emitted from Illinois industries and businesses. The authors must emphasize that the final result of the work is a preliminary emission inventory that was generated based on best available information and databases, and by exercising engineering judgment.

41562 (PB–90-220229/XAB) **Analysis of on-road remote sensing as a tool for automobile emissions control. Final report.** Stedman, D.H.; Bishop, G.A. Denver Univ., CO (USA). Dept. of Chemistry. Mar 1990. 186p. Available from NTIS, PC A09/MF A01.

The goal of the project was to demonstrate the ability of remote sensing to determine, and potentially lead to control of mobile source emissions in the Chicago metropolitan area. A remote sensor for on-road carbon monoxide motor vehicle emissions was used in conjunction with a video freeze-frame system which allows the instantaneous carbon monoxide emissions measurements obtained from passing vehicles to be superimposed on a picture of the vehicle and its license plate. The license plates can then be recorded and identified through state records and the emissions linked to that vehicle. The remote sensor for on-road carbon monoxide (CO) emissions has been developed at the University of Denver. The results have been verified by comparison to on-road and to on-dynamometer vehicle emissions readings.

41563 (PB–90-220831/XAB) **Stratification of particulate and VOC pollutants in horizontal-flow-paint spray booths. Report for September 1988-October 1989.** Darvin, C.H. Environmental Protection Agency, Research Triangle Park, NC (USA). Air and Energy Engineering Research Lab. 1990. 14p. (EPA–600/D-90/028). Available from NTIS, PC A03/MF A01.

The paper discusses stratification of particulate and volatile organic compound (VOC) pollutants in horizontal flow paint spray booths, as part of a joint U.S. Air Force/EPA research and development program on emissions from paint spray booths. The test program discussed in the paper was designed to characterize the pollutants both within and exiting a typical back-draw booth for which emissions control strategies are being developed. The results of one series of tests indicate that the pollutants, both particulate and VOC, fall to the lower level of the booth or stratify at the level at which they were generated. This might be expected since the densities of typical pollutants found in spray booths are greater than air. The results showed, however, that the concentration of pollutants in the lower level prior to exiting the booth was significantly greater than expected. Data indicated that, for the 16 ft (4.9 m) high booth tested, the concentration at the exit of the booth below the 8 ft (2.4 m) level was 5-25 times greater than the concentration above that level. The importance of these findings is that it might be possible to partition a booth's air flow into two zones, one lean and the other concentrated. The concentrated zone could be directed to a proportionally smaller VOC control system of significantly less capital and operating cost.

41564 (PB–90-221961/XAB) **Role of gas-phase Cl2 in the formation of PCDD/PCDF in municipal and hazardous waste combustion. Report for October 1989-March 1990.** Bruce, K.R.; Beach, L.O.; Gullett, B.K. Acurex Corp., Research Triangle Park, NC (USA). ©1990. 10p. Available from NTIS, PC A02/MF A01.

The paper proposes a scheme for controlling the formation of polychlorinated dibenzo-p-dioxins (PCDDs) and polychlorinated dibenzofurans (PCDFs) during incineration using sorbent materials to remove the source of chlorine at high temperature. Results of previous experiments investigating the formation of PCDD/PCDF through low temperature (300C), fly-ash-catalyzed reactions are demonstrated to have occurred through intermediate formation of gas-phase Cl2 by decomposition of the added catalyst CuCl2. The dependence of PCDD/PCDF formation rates on Cl2 concentration

is shown and the implications of the Deacon process on these rates is discussed.

41565 (PB–90-223678/XAB) **Greenhouse effect: Implications for economic development. Discussion paper.** Arrhenius, E.; Waltz, T.W. International Bank for Reconstruction and Development, Washington, DC (USA). ©1990. 29p. (WORLD BANK/DP–78). Available from NTISMF A01.

Library of Congress catalog card No. 90-12308. Microfiche copies only. Paper copy available from World Bank Publications, P.O. Box 7247-8619, Philadelphia, PA. 19170-8619. Phone: (201) 225-2165.

The paper presents a scientific perspective on the global climate change issue and establishes a comprehensive framework for efficient response to the implications for natural resource conservation and economic development. It has benefitted from extensive comment and review within the international scientific community, as well as within the World Bank. It comprises an extensive summary and critique, from a development viewpoint, of the sometimes conflicting scientific literature and opinion on the greenhouse effect, the related theoretical and empirical evidence, and prospects for global climate change. Finally, it presents a set of conclusions which are worthy of serious consideration by everyone concerned with the enlightened stewardship of the global environment.

41566 (PB–90-223751/XAB) **CRC-Radian evaporative emissions model: EVAP 2.0 annual report, 1988.** Kishan, S.; DeFries, T.H.; Klausmeier, R. Radian Corp., Austin, TX (USA). 29 Dec 1989. 252p. (DCN–89-245-052-04). Available from NTIS, PC A12/MF A02.

See also PB–88-246194.

In 1986, Radian initiated development of an improved vehicle evaporative emissions model – a model that expands upon the present EPA MOBILE4 to incorporate key factors affecting evaporative emissions rates. The 1988 annual report describes model improvements, including: the relationship between tank temperature and ambient temperature; a user interface to allow the input of user-selected multiple driving patterns; improved estimates of controlled and uncontrolled diurnal emissions for 1981+ vehicles and older model year vehicles; inclusion of additional to update diurnal and hot-soak emission factors; and to update the effect of fuel tank level on hot-soak and diurnal emissions; investigation of the relationships between driving behavior and fuel tank temperature.

41567 (PB–90-502022/XAB) **PM-10 Open Fugitive-Dust-Source computer model (for microcomputers). Model-Simulation.** Elmore, L. Environmental Protection Agency, Research Triangle Park, NC (USA). Office of Air Quality Planning and Standards. Apr 1990. vp. Available from NTISCP D02.

The model is contained on 5 1/4-inch diskettes, double density (360K), compatible with the IBM PC/AT microcomputer. The diskettes are in the ASCII format. Price includes documentation, PB–89-103691 and PB–90-207978.

The computer programs in the package are based on the material presented in the document, Control of Open Fugitive Dust Sources, EPA-450/3-88-008. The programs on these diskettes serve two purposes. Their primary purpose is to facilitate the process of data entry, allowing the user not only to enter and verify the data which he/she possesses, but also to access additional data which might not be readily available. The second purpose is to calculate emission rates for the particular source category selected using the data previously entered and verified. Software Description: The program is written in BASIC programming language for implementation on an IBM-PC/AT and compatible machines using DOS.2X or higher operating system. Hard disk with 5 1/4 inch disk drive or two disk drives, wide carriage printer (132-character) or printer capable of printing text in condensed mode required. Text editor or word processing program capable of manipulating ASCII or DOS text files is optional.

41568 (PB–90-502097/XAB) **National Acid Precipitation Assessment Program (NAPAP) Modelers' Emissions Inventory, 1985. Species allocation factors. Version 2. Data file.** Mobley, J.D.; Saeger, M. Environmental Protection Agency, Research Triangle Park, NC (USA). Air and Energy Engineering Research Lab. 1985. mag ta Available from NTISCP T03.

See also PB–88-137153, PB–88-137138, and PB–90-500992. Source tape is in the ASCII character set. This restricts preparation to 9 track, one-half inch tape only. Identify recording mode by specifying density only. For price at 6250 bpi density, call NTIS Computer Products. Price includes documentation, PB–90-212200.

The tape includes all of the files and data preparation programs required to implement the speciation processing of the 1985 NAPAP Emissions Inventory. The purpose and use of each of these files and programs are described in the referenced report. The report describes the methodologies and data bases used to develop species allocation factors and data processing software used to develop the 1985 National Acid Precipitation Assessment Program (NAPAP) Modelers' Emissions Inventory (Version 2). Species allocation factors were developed to convert annual emissions estimates of hydrocarbons, nitrogen oxides (NOx), and total suspended particulates (TSP) into more resolved classes to be used in modeling and assessment activities. The factors were used to divide: the hydrocarbon estimates in the annual inventory into 32 representative chemical classes based on common reactivity and product species, the NOx estimates into NO and NO2, and the TSP estimates into 15 classes based on component species and size ranges. Temporal, spatial, and pollutant species allocation factors have been developed to convert annual emissions data into resolved modeling formats suitable for use as input to regional transport models such as the Regional Acid Deposition Model. The level of resolution required for the allocation factors was defined by the modelers based on analyses of model performance and emissions data bases.

41569 (PB–90-869033/XAB) **Toxic and biomedical effects of textiles and textile production. January 1975-October 1989 (A Bibliography from World Textile Abstracts). Report for January 1975-October 1989.** National Technical Information Service, Springfield, VA (USA). May 1990. 67p. Available from NTISPC N01/MF N01.

Supersedes PB–86-862570.

This bibliography contains citations concerning toxicity and general health effects from the production of textiles. Vapors from burning flame resistant fabric, magnesium vapors from polyester foam, and toxic emissions from insulation, clothing, and upholstery are described and evaluated. Health effects resulting from formaldehyde use in treating fabrics for crease-resistance, lubricant use on polyester, textile mill effluents, and toxic substances found in textile mill room air are examined. (This updated bibliography contains 136 citations, 66 of which are new entries to the previous edition.)

41570 (PB–90-870023/XAB) **Waste disposal and pollution control in the metal manufacturing. January 1978-July 1989 (A Bibliography from Pollution Abstracts). Report for January 1978-July 1989.** National Technical Information Service, Springfield, VA (USA). May 1990. 84p. Available from NTISPC N01/MF N01.

Supersedes PB–82-866005.

This bibliography contains citations concerning industrial metal manufacturers' monitoring and control of waste disposal and pollution generators for processes other than finishing. Atmospheric emissions such as sulfur oxide, dust pollutants, nitrogen oxides, and ether gases are discussed relative to effects on surrounding vegetation and control. Heavy metal removal as well as waste water treatment processes are also included. (This updated bibliography contains 176 citations, 30 of which are new entries to the previous edition.)

41571 (PB–90-870536/XAB) **Best demonstrated available technology (BDAT) for pollution control and waste treatment. April 1975-May 1990 (A Bibliography from the NTIS data base). Report for April 1975-May 1990.** National Technical Information Service, Springfield, VA (USA). Jun 1990. 134p. Available from NTISPC N01/MF N01.

Supersedes PB–90-857202.

This bibliography contains citations concerning the most current equipment and processes for pollution control and waste treatment that attempt to meet the guidelines set by the Environmental Protection Agency (EPA). Technology for pollution control and waste treatment used by the EPA to develop current effluent standards, and pollution control methods used by industry to meet those standards are considered. Standards for gaseous, liquid, and solid

pollution are discussed. BDAT (Best Demonstrated Available Technology) is an acronym for best currently available technology as defined by the EPA. (This updated bibliography contains 241 citations, 20 of which are new entries to the previous edition.)

41572 (PB–90-871385/XAB) **Air pollution control and abatement: Computer analysis. January 1970-April 1990 (A Bibliography from the COMPENDEX data base). Report for January 1970-April 1990.** National Technical Information Service, Springfield, VA (USA). Jun 1990. 90p. Available from NTISPC N01/MF N01.

Supersedes PB–87-866646.

This bibliography contains citations concerning the application of computers in air pollution control and abatement. Topics include computerized mathematical modelling and simulation, computer-aided design, computer codes and calculations, operation performance analysis and evaluation, and the design of systems and equipment for air pollution control and abatement. (This updated bibliography contains 190 citations, 35 of which are new entries to the previous edition.)

41573 (PB–90-871658/XAB) **Chemical analysis of aerosols and airborne particulates. July 1980-May 1990 (A Bibliography from the NTIS data base). Report for July 1980-May 1990.** National Technical Information Service, Springfield, VA (USA). Jun 1990. 207p. Available from NTISPC N01/MF N01.

Supersedes PB–87-866851.

This bibliography contains citations concerning the use of various techniques and devices in the chemical analysis of aerosols and airborne particulate matter. Topics include studies of polycyclic aromatic hydrocarbons, sulfur and nitrogen compounds, and flue gas particulates by x-ray analyses, gas chromatography, and infrared and mass spectroscopy. Chemical composition and concentration analyses performed in specific areas are presented. Citations pertaining specifically to sampling techniques and particle size analysis are excluded. (This updated bibliography contains 356 citations, 74 of which are new entries to the previous edition.)

41574 (PB–90-871708/XAB) **Chemical analysis of trace elements for air pollution detection. August 1973-May 1990 (A Bibliography from the NTIS data base). Report for August 1973-May 1990.** National Technical Information Service, Springfield, VA (USA). Jun 1990. 72p. Available from NTISPC N01/MF N01.

This bibliography contains citations concerning the identification and analysis of trace elements and compounds occurring in air and airborne particulate samples. The citations present methods of analysis and the equipment required for the determinations. Analytical techniques include spectrometry, inductively-coupled plasma, atomic absorption and atomic emission, Fourier transform infrared analysis, and ion chromatography. A separate Published Search covers analysis of trace elements in water pollution detection. (Contains 103 citations fully indexed and including a title list.)

41575 (PNL–6450-32-HEDR) **Hanford Environmental Dose Reconstruction Project: Monthly report.** Finch, S.M. (comp.). Pacific Northwest Lab., Richland, WA (USA). Jun 1990. 57p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC06-76RL01830. Order Number DE90014297. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This monthly report summarizes the technical progress and project status for the Hanford Environmental Dose Reconstruction (HEDR) Project being conducted at Pacific Northwest Laboratory (PNL) under the direction of a Technical Steering Panel (TSP). The TSP is composed of experts in numerous technical fields related to this project and represents the interests of the public. The objective of the Hanford Environmental Dose Reconstruction Project is to estimate the radiation doses that populations could have received from nuclear operations at Hanford since 1944. The project is divided into technical tasks which address each of the primary steps in the path from radioactive releases to dose estimates: source terms, environmental transport, environmental monitoring data, demographics, agriculture, and food habits, and environmental pathways and dose estimates.

41576 (SAND–90-1795C) **The effect of gravity on particle collection in inertial impactors.** Marple, V.A. (Minnesota Univ., Minneapolis, MN (USA). Dept. of Mechanical Engineering); Olson, B.A.; Rader, D.J. Sandia National Labs., Albuquerque, NM (USA). [1990]. 4p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. (CONF-9009136–2: 3. international aerosol conference, Kyoto (Japan), 24-27 Sep 1990). Order Number DE90013372. Available from NTIS, PC A02/MF A01 - OSTI.

Gravitational forces have been found to be an important factor in defining the particle collection efficiency curve of inertial impactors for large particles. In general it was found that if the parameter $\hat{G} = gW/V_0^2$ (g is the gravitational acceleration, W is the nozzle diameter and V_0 is the average fluid velocity at the nozzle throat) in greater than 10^{-3}, the efficiency curve would shift to lower particle sizes. No effect could be seen for lower values of $\hat{G}$. 1 ref., 1 fig., 1 tab.

41577 (WHC-MR–0165) **Daily temperature, solar radiation, wind speed, cloud cover, and precipitation data recorded at the Meteorological Station for calendar years 1957–1988.** Skelly, W.A. Westinghouse Hanford Co., Richland, WA (USA). Jun 1990. 257p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC06-87RL10930. Order Number DE90014399. Available from NTIS, PC A12/MF A01 - OSTI; GPO Dep.

This miscellaneous report (MR) contains daily values of maximum, minimum, and dew-point temperature; wind speed; cloud cover; solar radiation; and precipitation measured at the Hanford Meteorological Station from January 1, 1957 to December 31, 1988. The Hanford Meteorological Station is operated by Pacific Northwest Laboratory (PNL) for the US Department of Energy.

41578 Carbon monoxide and the burning earth. Newell, R.E.; Reichle, H.G. Jr.; Seiler, W. *Scientific American (USA)*, 261(4): 82-88 (Oct 1989).

Carbon monoxide is one of many gases whose presence in the atmosphere is blamed largely on industrial activity in the Northern Hemisphere. Data collected by the authors show that the gas is also abundant in the Southern Hemisphere, where it comes mainly from the burning of tropical rain forests and savannas. The high levels of carbon monoxide confirm other evidence that the rain forests are being diminished rapidly, which may affect the climates of these regions as well as globally. Increases in carbon monoxide could also encourage the accumulation of pollutant gases such as ozone and methane. The first is highly toxic to plants and the second would add to the greenhouse effect.

41579 The changing atmosphere. Graedel, T.E.; Crutzen, P.J. *Scientific American (USA)*, 261(3): 58-68 (Sep 1989).

The chemistry of the atmosphere is changing, in large measure because of gases emitted by such human activities as farming, manufacturing, and the combustion of fossil fuels. The deleterious effects are increasingly evident; they may well become worse in the years ahead. This paper discusses the pollutants and the environmental perturbations with which they are associated. The authors believe the solution to the earth's environmental problems lies in a truly global effort.

41580 The changing climate. Schneider, S.H. *Scientific American (USA)*, 261(3): 70-79 (Sep 1989).

The earth owes its hospitable climate to the greenhouse effect, but now the effect threatens to intensify, rapidly warming the planet. Rising concentrations of carbon dioxide and other gases are the cause. The danger of warming is serious enough to warrant prompt action. The paper examines data on atmospheric warming and attempts to project effects into the future using atmospheric models. Three kinds of response to the threat are described: technical measures to counteract climatic change; adaptation to the changing climate; and prevention.

41581 The challenge of acid rain. Mohnen, V.A. *Scientific American (USA)*, 259(2): 30-38 (Aug 1988).

Acid rain's effects in soil and water leave no doubt about the need to control its causes. The main culprits are sulfur dioxide and nitrogen oxides, mainly from automobiles and power plants. This paper explains the extent of the problem in the USA. This paper also discusses environmentally and economically attractive technologies for the control of these pollutants: atmospheric fluidized bed combustion with limestone injection; pressurized fluidized bed

combustion;and coal gasification/combined-cycle power generation. Retrofitting of existing plants with flue gas desulfurization equipment offers the fastest way to reduce emissions immediately.

41582 Polynyas in the Southern Ocean. Gordon, A.L.; Comiso, J.C. *Scientific American (USA),* 258(6): 90-97 (Jun 1988).

One of the most surprising findings of the satellite era is that the ice cover surrounding Antarctica during the austral winter is not a continuous blanket. Within its borders, there are many small breaks from one to ten kilometers in size called leads. In addition there are vast regions called polynyas, up to 350,000 square kilometers, that are also completely free of ice. By venting heat rapidly, polynyas accelerate the global heat engine that drives motions of the seas and the atmosphere, helping to shape the world's climate. This paper discusses the existence, the extent, and the effects of polynyas.

41583 The Antarctic ozone hole. Stolarski, R.S. *Scientific American (USA),* 258(1): 30-36 (Jan 1988).

Because the effects are so serious, many investigators have been racing to determine the causes of the hole which develops each southern spring within the polar vortex, an isolated air mass that circulates around the South Pole during a large part of the year. This paper reviews two of the foremost theories for this ozone hole. Mechanisms of the pollution theory, which proposes that the cause is chlorofluorocarbons and nitrogen oxides in the atmosphere, are reviewed. The second theory proposes a natural shift in the air movements that transport ozone-rich air into the polar stratosphere during the southern spring as the cause. Current data suggest both theories are correct, but data are considered inconclusive.

41584 CO_2 climate sensitivity and snow-sea-ice albedo parameterization in an atmospheric GCM coupled to a mixed-layer ocean model. Meehl, G.A. (National Center for Atmospheric Research, Boulder, CO (USA)); Washington, W.M. *Climatic Change (Netherlands),* 16(3): 283-306 (Jun 1990).

The snow-sea-ice albedo parameterization in an atmospheric general circulation model (GCM), coupled to a simple mixed-layer ocean and run with an annual cycle of solar forcing, is altered from a version of the same model described by Washington and Meehl (1984). The model with the revised formulation is run to equilibrium for 1 x CO_2 and 2 x CO_2 experiments. The 1 x CO_2 (control) simulation produces a global mean climate about 1 degree warmer than the original version, and sea-ice extent is reduced. The model with the altered parameterization displays heightened sensitivity in the global means, but the geographical patterns of climate change due to increased carbon dioxide are qualitatively similar. The magnitude of the climate change is affected, not only in areas directly influenced by snow and ice changes but also in other regions of the globe, including the tropics where sea-surface temperature, evaporation, and precipitation over the oceans are greater. With the less-sensitive formulation, the global mean surface air temperature increase is 3.5 C, and the increase of global mean precipitation is 7.12%. The revised formulation produces a globally averaged surface air temperature increase of 4.04 C and a precipitation increase of 7.25%, as well as greater warming of the upper tropical troposphere. Sensitivity of surface hydrology is qualitatively similar between the two cases with the larger-magnitude changes in the revised snow and ice-albedo scheme experiment. Variability of surface air temperature in the model is comparable to observations in most areas except at high latitudes during winter. In those regions, temporal variation of the sea-ice margin and fluctuations of snow cover dependent on the snow-ice-albedo formulation contribute to larger-than-observed temperature variability. (Abstract Truncated)

41585 Tropical response to increased CO_2 in a GCM with a simple mixed layer ocean: Similarities to an observed Pacific warm event. Meehl, G.A. (National Center for Atmospheric Research, Boulder, CO (USA)); Washington, W.M. *Monthly Weather Review (USA),* 114: 667-674 (Apr 1986).

A version of the NCAR Community Climate Model (CCM), a global spectral atmospheric general circulation model, is coupled to a simple ocean mixed layer model with fixed depth. This mixed layer model is a simple slab of water that crudely accounts for seasonal heat storage but has no dynamics (e.g., advection, diffusion or upwelling). As a result, tropical sea surface temperatures (SSTs) produced by the simple mixed layer are warmer than observed in the equatorial tropics on the order of 1°-2°C. However, this uniform longitudinal warming is not associated with uniform longitudinal increases of tropical precipitation. Greatest area-averaged increases of precipitation occur in the tropical Pacific, while decreases of area-averaged precipitation are noted in the Asian monsoon regions. This is attributed to a disruption of the east-west circulation between the Pacific and Indian sectors similar to that observed during Pacific Warm Events. Accordingly, a number of the features of the model response to increased CO_2 resemble those of a Warm Event. These include, for example, westerly upper-level wind anomalies in the subtropics of the pacific in both hemispheres, westerly similarities, it is emphasized that the real climate system may respond differently to an increase in CO_2 due to the importance of tropical ocean dynamics that are not included in the present simple mixed-layer ocean model. The next step in the modeling hierarchy, an ocean GCM coupled to the NCAR CCM, will show how the response in the tropics, documented here for SSTs determined only by surface energy balance and crude ocean heat storage, may be affected by the addition of ocean dynamics.

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Refer also to citation(s) 40363, 40416, 40422, 40459, 40461, 40785, 40868, 40869, 40936, 41246, 41523, 41535, 41571, 41575, 41581, 41612, 41614, 41624, 41625, 41626, 41627, 41628, 41629, 41630, 41631, 41636, 41641, 41646, 41648, 41649, 41650, 41651, 41652, 41653, 41661, 41664, 41699, 41708, 41717, 41753

41586 (AD-A-220771/0/XAB) **Phase-screen method for elastic wave and seismic discrimination. Report for February 1989-February 1990.** Fisk, M.D.; McCartor, G.D. Mission Research Corp., Santa Barbara, CA (USA). 15 Dec 1989. 82p. (SCIENTIFIC-1). Available from NTIS, PC A05/MF A01.

The phase-screen method to compute elastic vector wave propagation in three-dimensional heterogeneous media is developed, accounting for the difference in phase velocities of the transverse and longitudinal polarizations. The method replaces the heterogeneous medium with a homogeneous one and a set of phase screens. Between the screens the displacement is propagated by the uniform elastodynamic wave equation. The phase of each polarization of the wave, accumulated from propagating in the z-direction, is corrected at the screens to account for inhomogeneities. Only forward propagation is included in the analysis. A criterion is derived to determine the number of phase screens to be used. The energy fluxes of the S and P waves are also computed. We find that energy conservation requires special consideration for application of the method to vector waves. The method is tested on a two-dimensional problem whose exact solution is also computed. The primary application of the method is to compute vector wave propagation in random media for the purpose of treaty monitoring. In particular, we demonstrate how P-S conversion and SH-SV ratios may be efficiently computed for realistic media by employing the phase-screen method on statistical modeling.

41587 (BFB-63, pp. 31-37) **Radionuclide from Chernobyl as tracers in the Neusiedlersee region: Physical foundations.** Rank, D. (Bundesversuchs- und Forschungsanstalt Arsenal, Vienna (Austria)). Biologisches Forschungsinstitut Burgenland, Illmitz (Austria). 1987. (In German). (CONF-8611310--: 12. meeting of the Neusiedlersee, Illmitz (Austria), 20 Nov 1986). In *12. meeting on the Neusiedlersee.* Available from Biologisches Forschungsinstitut Burgenland A-7142 Illmitz.

The radionuclide fallout after the Chernobyl accident can be viewed as surface marking and used to investigate scientifical problems like the penetration rate of noxious substances into the underground, sedimentation rate in surface waters or the investigation of ecological cycles. The region around the lake Neusiedlersee in eastern Austria (the lake being without drainage) is an intriguing model system, as the amount of radionuclides is conserved and is removed radioactive decay only. Some physical fundamentals of radionuclide concentration interpretations are outlined. In addition to the Neusiedlersee regions, sediments in the Danube river are

considered. The most important isotopes are the long-lived strontium 90 and cesium 137. 6 refs., 6 figs., 1 tab.

41588 (BFB–63, pp. 39-48) **Radioactive contamination of foodstuffs from Burgenland after Chernobyl.** Maringer, F.J. (Bundesversuchs- und Forschungsanstalt Arsenal, Vienna (Austria). Geotechnisches Inst.). Biologisches Forschungsinstitut Burgenland, Illmitz (Austria). 1987. (In German). (CONF-8611310–: 12. meeting of the Neusiedlersee, Illmitz (Austria), 20 Nov 1986). In *12. meeting on the Neusiedlersee.* Available from Biologisches Forschungsinstitut Burgenland A-7142 Illmitz.

About 500 samples of foodstuffs, drinking water and grass from Burgenland (an eastern province of Austria) were measured by the author's institution in May to August 1986. Burgenland and generally the east of Austria had, with respect to the Chernobyl fallout, an advantage against other parts of Austria, due to low rainfall and favorable winds in the days after the Chernobyl accident. The activities were generally below the legal limits for drinking water and higher than these in few cases in foodstuffs and grass. The legal limits for activity concentrations in foodstuffs and drinking water for the elements iodine 131, cesium 134, cesium 137 and strontium 90 are listed in an appendix. 2 refs., 6 figs., 5 tabs.

41589 (DOE/ER/60577–T2) **Generation and mobility of radon in soil: Annual technical progress report.** Rose, A.W. Pennsylvania State Univ., University Park, PA (USA). 25 Apr 1990. 35p. Sponsored by U.S. DOE Energy Research. DOE Contract FG02-87ER60577. Order Number DE90014376. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This report discusses progress from March 1987–June 1990. Objectives of this project are to: evaluate the extent and nature of uranium and radium depletion and/or enrichment in soil horizons as a function of climate and other factors affecting soil character; evaluate the relation of radon emanation coefficient to soil type, soil properties, soil-forming factors, and radon levels in soil gas; and evaluate the relations of fragipans, soil moisture and soil permeability to radon concentration and radon flux in soil profiles. The approach has been to investigate in detail 13 soil profiles selected to represent distinct differences in parent material (limestone, sandstone, shale, granite), major soil groups (Alfisols, Ultisol, Inceptisol, Mollisol, Spodosol), and moisture regimes (well-drained to somewhat poorly drained with fragipan). The 13 profiles investigated in the past 3 years are in Pennsylvania, North Carolina, New York, Tennessee, Illinois, and represent highly varied soil types. Samples from five profiles in Georgia have also been analyzed in less detail. A combination of pedologic, geochemical and radiometric methods have been applied to understanding radon at these sites. 12 refs., 14 figs., 5 tabs.

41590 (DOE/NV/10845–01) **Community Radiation Monitoring Program: Annual report, October 1, 1988–September 30, 1989.** Lucas, R.P. Jr.; Cooper, E.N.; McArthur, R.D. Nevada Univ., Las Vegas, NV (USA). Desert Research Inst. May 1990. 53p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC08-90NV10845. Order Number DE90014393. Available from NTIS, PC A04/MF A01; OSTI; INIS; GPO Dep.

The Community Radiation Monitoring Program began its ninth year in the summer of 1989, continuing as an essential portion of the Environmental Protection Agency's long-standing off-site monitoring effort. It is a cooperative venture between the Department of Energy (DOE), the Environmental Protection Agency (EPA), the University of Utah (U of U), and the Desert Research Institute (DRI) of the University of Nevada System. The objectives of the program include enhancing and augmenting the collection of environmental radiation data at selected sites around the Nevada Test Site (NTS), increasing public awareness of that effort, and involving, in as many ways as possible, the residents of the off-site area in these and other areas related to testing nuclear weapons. This understanding and improved communication is fostered by hiring residents of the communities where the monitoring stations are located as program representatives, presenting public education forums in those and other communities, disseminating information on radiation monitoring and related subjects, and developing and maintaining contacts with local citizens and elected officials in the off-site areas. 8 refs., 4 figs., 4 tabs.

41591 (ECN-PB–89-7) **ECN research on acidification.** Keuken, M.P.; Mallant, R.K.A.M.; Woltiez, J.R.W.; Das, H.A.; Slanina, J. Netherlands Energy Research Foundation, Petten (Netherlands). Dec 1989. 46p. (In Dutch). Order Number DE90797094. Available from NTIS (US Sales Only), PC A03/MF A01.

The last three years (1986-1989) the Netherlands Energy Research Foundation sudied mainly acidification problems. Recently research has been extended to mondial air pollution and climatic change. Knowledge must be available on air pollution from emission at the source to uptake in vegetation or soil and the effects of air pollutants on plants, animals and human beings, in order to estimate the consequences of certain techniques to produce energy. Therefore ECN carried out research on: emissions from fossil fuels power plants (aerosols and trace elements); dry and wet deposition, uptake of air pollutants by fog, dew and clouds, and the effects of this uptake; the conversion of deposited air pollution in soils (ammonia to nitrates), and finally the design of computer models and carrying out evaluation studies. Results of these studies are presented (except for aerosols and trace elements which contributed little to acidification). 28 figs., 12 tabs., 22 refs.

41592 (EGG–10282-1095) **An aerial radiological survey of Technical Area 15 and surroundings, Los Alamos National Laboratory, Los Alamos, New Mexico: Date of Survey: September 1982.** Fritzsche, A.E. EG and G Energy Measurements, Inc., Las Vegas, NV (USA). Remote Sensing Lab. Sep 1989. 18p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC08-83NV10282. Order Number DE90014193. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

An aerial gamma survey of the entire Los Alamos National Laboratory and the adjacent area was flown in September 1982. The data from a part of the survey, Technical Area 15, are presented here. Other parts of the survey data that will complete the presentation will be published in a separate report. The gamma survey data show significant Pa-234m activity which implies U-238 activity above background levels. Concentration isopleths overlaid on aerial photographs of this area indicate the position and extent of this isotope. The inventory of Pa-234m (above background) is probably between 4 and 23 curies, depending on the actual vertical distribution of the Pa-234m in the soil. Isopleth maps of the natural background gamma exposure rates and the total exposure rates (natural plus exposure due to Pa-234m) are included. Implied exposure rates at 1 meter above the ground range from a minimum terrestrial component of 6μR/h to 22μR/h over areas where Pa-234m and the parent, U-238, exist. 1 ref., 5 figs., 3 tabs.

41593 (EPRI-GS–6875) **Release and attenuation of PCB [polychlorinated biphenyl] congeners: Measurement of desorption kinetics and equilibrium sorption partition coefficients: Final report.** Girvin, D.C. (Pacific Northwest Lab., Richland, WA (USA)); Sklarew, D.S.; Scott, A.J.; Zipperer, J.P. Electric Power Research Inst., Palo Alto, CA (USA); Pacific Northwest Lab., Richland, WA (USA). ©Jun 1990. 132p. Sponsored by Electric Power Research Institute. DOE Contract AC06-76RL01830. Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

Polychlorinated biphenyls (PCBs) have been used widely in electrical equipment such as capacitors and transformers because of their coolant-insulation properties. However, their use has been discontinued because of their perceived toxicity to humans and other organisms in conjunction with their environmental persistence. This report provides information on the desorption or release rates of individual PCB congeners from four utility substation soils contaminated with Aroclor mixtures when these soils are in contact with water and the distribution of these congeners between the rapidly and the slowly released fractions of the total congeners bound to the soils. In addition to this kinetic information, experimental equilibrium sorption (partition) coefficients for individual PCB congeners have been measured for a series of eight soils differing in their organic carbon and clay mineral contents, from various locations throughout the United States. From these coefficients, a predictive relationship was derived for estimating partitioning coefficients for soils and congeners for which no sorption data are available. 49 refs., 9 figs., 13 tabs.

41594 (EUR–11255) **The transfer of radionuclides through foodchains following accidental releases to atmosphere.** Simmonds, J.R. (National Radiological Protection Board Chilton (UK)); Haywood, S.M.; Steinhauer, C. Commission of the European Communities, Luxembourg (Luxembourg). 1987. 41p. CEC under contracts Nos BIO-F-542-83-UK and BIO-F-539-83-D. Available from NTIS (US Sales Only), PC A03/MF A01.

The contamination of agricultural land is an important potential consequence of accidental releases of radioactive materials to atmosphere and must be considered in accident consequence assessments. In this report the terrestrial foodchain models used in Europe are reviewed in the context of the assessment of accidental releases. The influence of the time of the year at which a release occurs on the agricultural consequences is discussed, as is the relative importance of the terrestrial foodchain pathway compared with other long-term exposure pathways. Recommendations are made on the most appropriate type of foodchain model for use in accident consequence assessments and the limitations of various parts of the modelling system are identified. In addition, the importance of aquatic foodchain pathways following accidental releases to atmosphere is briefly discussed. This investigation into the transfer of radionuclides through foodchains was carried out as part of project MARIA (Methods for Assessing the Radiological Impact of Accidents), a programme of work to review and improve methods for nuclear accident consequence assessments.

41595 (IC–89/354) **Some physical properties of wetland soils with reference to the tropics.** Obi, M.E. International Centre for Theoretical Physics, Trieste (Italy). Oct 1989. 26p. Order Number DE90633601. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Some physical properties of wetland soils are reviewed with reference to the tropical regions. The soils have a common feature periodic flooding during the year. They exhibit wide variability in mechanical composition in accordance with their genesis and location. Bulk densities range from 1.0 to 1.9 Mg m^{-3} for mineral soils with moderate organic matter content and from about 0.02 to 0.2 Mg m^{-3} for organic soils. Total porosities are generally high with dominance of micropores in organic and clayey wetland soils. Shrink-swell potential is also generally high in many of these wetland types with consequent problems of crack formation. Anaerobiosis condition is a common feature in wetland soils. Also carbon dioxide levels may be excessive for normal crop development. Water-retentivity has been found to be high to very high to in a number of tropical wetland soils of medium to fine texture. In some organic soils values of over 100% (mass basis) are not uncommon. In particular, a value of up to 3000% has been reported. Water infiltration and percolation are highly variable. The heat capacities are generally high with resultant reduced temperatures. Land use and management strategies are proferred in the light of the properties. (author). 44 refs, 9 tabs.

41596 (IG–90/01) **The tritium content of precipitation and surface water in Austria in 1989.** Rank, D. (Bundesversuchs- und Forschungsanstalt Arsenal, Vienna (Austria). Geotechnisches Inst.); Rajner, V.; Lust, G. Bundesversuchs- und Forschungsanstalt Arsenal, Vienna (Austria). 1990. 35p. (In German). Order Number DE90633825. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

This report includes weighted monthly ^{3}H-means for 23 precipitation sampling stations, ^{3}H-concentrations of daily precipitation samples from the station Wien-Arsenal, and ^{3}H-concentrations of monthly samples from 17 surface water sampling stations. 4 refs., 3 tabs., 18 figs. (Authors).

41597 (INP–1350/B) **On radioactivity measurements of water, milk and dairy products, vegetables and grass from the surroundings of Krakow on the aftermath of Chernobyl reactor accident.** Grychowski, P. (and others); Mazgaj, Z.; Mikulski, J. Institute of Nuclear Physics, Cracow (Poland). 1987. 62p. (In Polish). Order Number DE90633847. Available from NTIS (US Sales Only), PC A04/MF A01; OSTI; INIS.

After the Chernobyl reactor accident, prompted by the Director General of the Governmental Atomic Agency (PAA), an informal group consisting of members of laboratories from the Institute of Nuclear Physics began to measure the radioactivity of food products from the surroundings of Krakow. The highest values of contamination of water from rivers by ^{131}I were attained in the Vistula river on 2-nd of May (530 Bq/dm^3). The values levelled down by the end of May amounting to 2 Bq/dm^3. The contamination of dairy products was highest for sheeps white cheese, where highest values reached 19 kBq/kg of ^{131}I, whereas the highest values of ^{131}I radioactivities from cows milk were 650 Bq/dm^3. The decrease of radiation levels was faster than governed by radioactive decay only. The additional half-life corresponding most probably to washing out of ^{131}I from sheep food amounted to 10 days. Measurements of food contamination by ^{134}Cs, ^{137}Cs and ^{132}Te were also carried out. The additional effective dose equivalent during the month of May for the population related to the Chernobyl accident was estimated at 0,45 mSv (45 mrem). 14 refs., 21 figs., 9 tabs. (author).

41598 (JINR-R–14-89-101) **The phosphorus fertilizer production as a source of rare-earth elements pollution of the environment.** Volokh, A.A. (AN SSSR, Moscow (USSR). Inst. Mineralogii, Geokhimii i Kristallokhimii Redkikh Ehlementov); Gorbunov, A.V.; Revich, B.A.; Gundorina, S.F.; Frontas'eva, M.V.; Chen Sen Pal. Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Neutron Physics. 1989. 10p. (In Russian). Order Number DE90633602. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

This paper considers some peculiarities of the production of phosphorus fertilizers from the point of view of the pollution of the environment with rare-earth elements. The principal possibility is demonstrated of the determination of the influence of a given type of production on the environment by measuring the change in the rare-arth elements interrelationship in the show. The main source of industrial dust is identified. The distribution of pollutants in dependence on the size of aerosol particles is given. The data on the concentrations of the pollutants in agricultural plants, employees hair and hair of local residents are also reported. 8 refs.; 4 figs.; 4 tabs.

41599 (LA–11795-MS) **Transport of plutonium in snowmelt run-off.** Purtymun, W.D.; Peters, R.; Maes, M.N. Los Alamos National Lab., NM (USA). Jul 1990. 15p. Sponsored by U.S. DOE Management & Administration. DOE Contract W-7405-ENG-36. Order Number DE90013623. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Plutonium in treated low-level radioactive effluents released into intermittent streams is bound by ion exchange or adsorption to bed sediments in the stream channel. These sediments are subject to transport with summer and spring snowmelt run-off. A study was made of the transport of plutonium during seven spring run-off events in Los Alamos and Pueblo canyons from the Laboratory boundary to Otowi on the Rio Grande. The melting of the snowpack during these years resulted in run-off that was large enough to reach the eastern edge of the Laboratory. Of these seven run-off events recorded at the Laboratory boundary, only five had sufficient flow to reach the Rio Grande. The volume of the five events that reached the river ranged from 5×10^3 m^3 to 104×10^3 m^3. The five run-off events carried 119×10^3 kg of suspended sediments and 1073×10^3 kg of bed sediments, and transported 598 μCi of plutonium to the river. Of the 598 μCi of plutonium, 3% was transported in solution, 57% with suspended sediments, and 40% with bed sediments. 13 refs., 3 figs., 6 tabs.

41600 (ORNL/FTR–3648) **[Mercury as an environmental pollutant]: Foreign trip report, June 7, 1990–June 14, 1990.** Turner, R.R. Oak Ridge National Lab., TN (USA). 28 Jun 1990. 9p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC05-84OR21400. Order Number DE90013392. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The traveler attended the conference "Mercury as an Environmental Pollutant" and presented a technical poster entitled "Biotransformations of Mercury in Contaminated and Control Streams in Relation to the Abundance of Microbial Gene Sequences Encoding Mercury Resistance." Although a great deal of the subject matter of the conference dealt with the biogeochemical cycling of mercury in aquatic and terrestrial systems which have not been subjected directly to industrial pollution, several presentations addressed contamination scenarios similar to those at the

Oak Ridge site. These included one presentation concerning application of ion exchange resins in the treatment of mercury-contaminated wastewater and soil, and several concerning the role of mercury-resistant bacteria in biotransformations of mercury at contaminated sites. The Swedish experience with various methods of treating lakes to reduce mercury in fish was the subject of several presentations and one field trip.

41601 (ORNL/M–1074) **Field detection of volatile organic vapors from soil and water matrices.** Goldsmith, J.G.; Taylor, F.G. Jr. Oak Ridge National Lab., TN (USA). Jul 1990. 20p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE90013636. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The collection of subsurface soil or sediment samples in survey or screening studies for subsequent volatile organic analysis in the laboratory introduces many considerations including the number of samples to be collected along a depth profile, which subsample to submit, and what treatment and preservation are ideal before sample analysis. Ideally, the sample with the greatest probability for confirming a leaking tank or a spill site would reduce project costs considerably. Using a field compatible photoionization detector, a series of studies using xylene, benzene, and trichloroethylene contaminated soils or water placed in small chambers under temperature control were conducted to simulate field situations. The water contamination study was designed to mimic sampling well headspace for the presence of volatile organic compounds. The results have provided a basis for field screening and sample selection for soils containing volatile organic contaminants and identified some important considerations for screening well headspaces for organic contamination. 4 refs., 7 figs., 4 tabs.

41602 (PB–90-208349/XAB) **Health assessment for Strasburg Landfill Coatesville, Chester County, Pennsylvania, Region 3. CERCLIS No. PAD000441337. Preliminary report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 25 Oct 1989. 15p. Available from NTIS, PC A03/MF A01.

The Strasburg Landfill is an inactive 22-acre facility that is part of a 220 acre site. The site is located south of Strasburg Road (Route 162) in western Newlin Township, Chester County, Pennsylvania. Numerous volatile organic compounds (VOC) have been detected in groundwater and leachate from the site. Many of the samples were not analyzed for the full spectrum of priority pollutants. Therefore, other chemicals may be present in the sample. The site is of potential health concern because of the risk to human health resulting from possible exposure to hazardous substances at concentrations that may result in adverse health effects.

41603 (PB–90-212564/XAB) **Mobility and degradation of residues at hazardous-waste land-treatment sites at closure. Final report, September 1987-April 1990.** Loehr, R.C.; Erickson, D.C.; Rogers, L.A.; Kelmar, D.M. Texas Univ., Austin, TX (USA). Apr 1990. 183p. Available from NTIS, PC A09/MF A01.

Soil treatment systems that are designed and managed based on a knowledge of soil-waste interactions may represent a significant technology for simultaneous treatment and ultimate disposal of selected hazardous wastes in an environmentally acceptable manner. These soil treatment systems cease operations for various reasons and undergo a closure process. The process is performed to minimize the long-term migration of waste constituents from the soil treatment system. Decisions pertaining to the closure process often center around the various closure scenarios. There is currently a lack of scientifically derived fate and transport information for the wide range of hazardous chemicals for which such decisions can be made. The report presents information pertaining to the quantitative evaluation of mobility and persistence of organic and inorganic waste constituents which have accumulated over a long-term period in soil treatment systems under various closure scenarios. The information will be useful in the development of soil treatment closure decisions which will be protective of human health and the environment.

41604 (PB–90-216268/XAB) **Mobilization of aviation gasoline from a residual source.** Ostendorf, D.W.; Kampbell, D.H.; Wilson, J.T.; Sammons, J.H. Traverse Group, Inc., Ann Arbor, MI (USA). ©1989. 9p. Available from NTIS, PC A02/MF A01.

Pub. in Research Jnl. of WPCF (Water Pollution Control Federation), Vol. 61, No. 11-12, 1684-1690(Nov-Dec 1989).

A simple one-dimensional model describes the mobilization of 90 cu m of residual aviation gasoline from an 80-m diameter, 0.306-m thick contaminated soil mass at the US Coast Guard Air Station in Traverse City, Michigan. Originally deposited under a paved ground surface in December 1969, the bound product is thought to be entrained as a separate phase by episodic incursions of the water table in the assumed absence of dissolution, biodegradation, and volatilization. The coupled transport processes of storage, advection, and water table flushing govern the gasoline concentration subject to a presumed linear sorption relation between mobilized and stationary residual phases. A retardation factor of 13.1 calibrates soil-core data taken at the site from August 1987 to December 1988, with a standard deviation of 26%, indicating a reasonable degree of accuracy. The present position of the leading edge of contamination endorses the calibrated retardation factor value as well.

41605 (PB–90-216995/XAB) **Soil vapor extraction VOC control technology assessment. Final report.** Pacific Environmental Services, Inc., Durham, NC (USA). Sep 1989. 74p. Available from NTIS, PC A04/MF A01.

Soil Vapor Extraction (SVE) is an emerging technology in which volatile organic chemicals (VOC) are extracted from soil through use of a vacuum system. The decision to employ a VOC control system treatment is largely dependent upon VOC concentrations and applicable regulations. The selection of a particular VOC treatment option may be somewhat more complicated and based upon individual site characteristics. Pacific Environmental Services, Inc. (PES) was contracted by the U.S. EPA to investigate and evaluate potential VOC control techniques for use at SVE sites. The purpose of the investigation is to gain insight into the operation of SVE systems in general and to develop and summarize information on the factors associated with determining applicable VOC control systems. These factors include the feasibility, relative cost, and performance of various air pollution control techniques.

41606 (PB–90-219338/XAB) **Technical assistance to the Montana Department of Health and Environmental Sciences. Blood lead testing of people living near Silver Bow Creek NPL site, Walkerville, Montana. Final report.** Baburich, S.B.; Lybarger, J.A. Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). Mar 1988. 13p. (ATSDR/HS–90/06). Available from NTIS, PC A03/MF A01.

The Agency for Toxic Substances and Disease Registry (ATSDR), Office of Health Assessment (OHA) assisted the Montana Department of Health and Environmental Sciences (MDHES) in conducting blood lead testing for residents of Walkerville, Montana. The testing was offered because lead contamination of soil had been documented in Walkerville as ranging from below the limit of detection (LOD) to 11,000 ppm, and no blood lead testing had recently been offered to area residents. Historically, Silver Bow Creek was the site of large-scale mining, and the residential areas of Walkerville are currently located on or near mine tailing piles. Results of the blood testing were all below 25 ug/dl (Centers for Disease Control (CDC) recommended level). Two children, however, with higher blood lead results (17.3 ug/dl in a 5 year old and 22.5 ug/dl in a 7 year old) were referred to the MDHES for environmental evaluation.

41607 (PB–90-219379/XAB) **Technical assistance to the Chester County, Pennsylvania Health Department. Exposure study of persons possibly exposed to polychlorinated biphenyls in Paoli, Pennsylvania. Final report.** Mortensen, B.K.; Anderson, J.E.; Burse, V.W.; Garrett, W.A.; Kotlovker, D. Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). Nov 1987. 30p. (ATSDR/HS–90/01). Available from NTIS, PC A03/MF A01.

An epidemiologic investigation of possible exposure to polychlorinated biphenyls (PCBs) was conducted following the discovery of widespread soil PCB contamination in Paoli, Pennsylvania. Concentration of PCBs in yard and street soil ranged from less than 1 ppm to more than 6,400 ppm. From several neighborhoods adjacent to or immediately downgradient from the source of contamination, 66 persons were selected through probability sampling

to represent the entire population of the neighborhoods (396 persons). The geometric mean and distribution of serum PCB concentrations in the group did not differ from the means and distributions of a large sample of persons selected from across the United States having no known environmental exposure. Thus, the population near the site in Paoli did not show exposure different from other U.S. populations.

41608 (PB–90-220518/XAB) **Predicting movement of selected metals in soil: Application to disposal problems.** Fuller, W.H. Arizona Univ., Tucson, AZ (USA). Dept. of Soils, Water and Engineering. Jan 1990. 6p. Available from NTIS, PC A02/MF A01.

Data from laboratory column studies of movement of selected metals in Municipal Solid Waste (MSW) leachate through soils from several parts of the U.S. were used as a base for developing simple field-oriented tools for predicting pollutant movement. The metals studied were arsenic, beryllium, cadmium, chromium, copper, iron, mercury, nickel, lead, selenium, vanadium and zinc. Principal variables in the laboratory study and in the models were (a) soil physical/chemical properties such as clay content, pH, and iron/manganese hydrousoxide content, and, (b) leachate properties such as total organic carbon (TOC) and total salts. The first model was based on the Lapidus and Amundson (L-A) equation. A simpler, more adaptable model based on the Error Function equation was developed and tested. Predictions for rates of metal movement through soil in municipal solid waste leachates were equally effective by either model but the L-A method of developing the model was somewhat more difficult. Movement rates and soil and leachate characteristics that influences rates were identified; the results have not been incorporated into the model.

41609 (PB–90-220542/XAB) **Superfund Record of Decision (EPA Region 2): Forest Glen Subdivision, Niagara Falls, NY. (First remedial action), December 1989.** Environmental Protection Agency, Washington, DC (USA). Office of Emergency and Remedial Response. 29 Dec 1989. 165p. (EPA/ROD/R–02-90/099). Available from NTIS, PC A08/MF A01.

Portions of this document are not fully legible.

The Forest Glen Subdivision site consists of 21 acres of developed residential properties and undeveloped land in Niagara Fall, Niagara County, New York. Land in the area surrounding the Forest Glen subdivision is used for residential and industrial purposes, including a mobile home park, small shopping mall, and the CECOS Landfill. Chemical companies reportedly disposed of wastes onsite from the early 1950s to the early 1970s. Sampling by EPA's Field Investigation Team revealed the presence of high concentrations of unknown and tentatively identified compounds (TICs) in August 1987, and further soil sampling was conducted to identify the TICs. EPA has executed interim measures to stabilize site conditions including collecting, staging, and securing drums in areas north and east of the subdivision and temporarily covering visibily contaminated soil with concrete. The remedial activity is the first of two planned operable units and addresses resident relocation only. A subsequent operable unit will address the remediation of site contamination once the relocation is complete.

41610 Microbial degradation of trichloroethylene in the rhizosphere: Potential application to biological remediation of waste sites. Walton, B.T. (Oak Ridge National Laboratory, TN (USA)); Anderson, T.A. *Applied and Environmental Microbiology (USA),* 56(4): 1012-1016 (Apr 1990).

The possibility that vegetation may be used to actively promote microbial restoration of chemically contaminated soils was tested by using rhizosphere and nonvegetated soils collected from a trichloroethylene (TCE)-contaminated field site. Biomass determinations, disappearance of TCE from the headspace of spiked soil slurries, and mineralization of [14C]TCE to 14CO2 all showed that microbial activity is greater in rhizosphere soils and that TCE degradation occurs faster in the rhizosphere than in the edaphosphere. Thus, vegetation may be an important variable in the biological restoration of surface and near-surface soils.

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Refer also to citation(s) 40329, 40363, 40398, 40417, 40423, 40432, 40460, 40461, 40487, 40488, 40489, 40490, 40491, 40492, 40493, 40494, 40868, 40869, 41523, 41559, 41571, 41575, 41581, 41584, 41585, 41591, 41593, 41594, 41599, 41600, 41601, 41602, 41708, 41709, 41717, 42298

41611 (AD-A–220495/6/XAB) **Synopsis of research needs workshop: Development of leach tests for contaminated dredged material held in Baton Rouge, Louisiana on 23-24 June 1988. Final report.** Louisiana State Univ., Baton Rouge, LA (USA). Louisiana Water Resources Research Inst. Feb 1990. 33p. Available from NTIS, PC A03/MF A01.

This report presents the findings of a research needs workshop on the development of leach tests for contaminated dredged material, held 23-24 June 1988 in Baton Rouge, LA. The workshop was hosted by the Louisiana Water Resources Research Institute and the US Army Engineer Waterways Experiment Station (WES). The workshop participants reviewed results of research on test procedures developed by the WES and provided eight recommendations for directing future research in this area. Workshop panelists were of the opinion that research conducted to date was good and generally validated the basic technical approaches suggested by the 1984 Corps leachate quality working group. However, the consensus was that much research remains to be done before a leach test (s) will be available for routine use.

41612 (AD-A–220610/0/XAB) **Environmental transformation products of nitroaromatics and nitramines: Literature review and recommendations for analytical method development. Special report.** Walsh, M.E. Cold Regions Research and Engineering Lab., Hanover, NH (USA). Feb 1990. 28p. (CRREL-SP–90-2). Available from NTIS, PC A03/MF A01.

One of the Army's major environmental problems is the contamination of soil and water with residues of explosives at many military facilities. This contamination occurred during the disposal of wastewater from production and load-and-pack operations, burning or detonation of off-specification material, and destruction of out of date explosives. The objective of this study was to review the literature to identify the products formed after explosives enter the environment and to identify those compounds for which certified analytical methods should be developed. Also, analytical methodology already developed for these compounds is summarized. The literature describing the environmental transformation of organic explosives and related compounds is reviewed in an attempt to identify those by-products for which certified analytical methods should be developed. Among those compounds identified are TNT reduction products (aminodinitrotoluenes and diaminonitrotoluenes) and coupling products (azoxytoluenes). The development of methods is also recommended for the amino derivatives of DNT, TNB, and DNB, as well as the nitroso derivatives of HMX and RDX.

41613 (CONF-9002130–1) **Individual-based modeling, population dynamics, and fisheries recruitment success.** Rose, K.A.; DeAngelis, D.L.; Barnthouse, W.; Van Winkle, W. Oak Ridge National Lab., TN (USA). [1990]. 18p. Sponsored by Electric Power Research Institute. DOE Contract AC05-84OR21400. RP2932–2. From Fisheries-oceanography coordinated investigation (FOCI) workshop on fisheries recruitment modelling; Seattle, WA (USA); 26-27 Feb 1990. Order Number DE90013826. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Prediction of recruitment success is a critical problem in fisheries research. From a theoretical perspective, the ability to predict the number and characteristics of reproducing survivors underlies the field of quantitative population dynamics. Form a practical perspective, rationale and efficient management of fisheries resources requires the ability to accurately forecast the effects of disturbances, both natural and anthropogenic in origin, on fish populations. The objective of this paper is to advocate individual-based modelling as an alternative to the more traditional approaches for predicting recruitment success. First, some reasons for the limited success to date in making long-term predictions of fisheries recruitment are summarized. The importance of information on individuals, rather than on the average individual, is then

illustrated as the "fallacy of the average" using two sets of experimental data. The general ideas behind individual-based modelling, and four examples of individual-based models involving fish, are then briefly described. Finally, we make some concluding remarks. Two caveats are necessary. This paper is a summary of a workshop presentation; we therefore take many liberties and make gross generalizations throughout the paper. Also, although not explicitly stated, our discussion is based more on estuarine and marine, than on freshwater, fishes. 8 refs., 6 figs.

41614 (CONF-9009178–2) **Scoping and field techniques to improve performance on hazardous waste site investigations.** Nickelson, M.D. (Martin Marietta Energy Systems, Inc., Oak Ridge, TN (USA)); Janssen, L.A.; Sczurko, J.J. Jr. Martin Marietta Energy Systems, Inc., Oak Ridge, TN (USA). [1990]. 3p. Sponsored by U.S. DOE Environment Health & Safety. DOE Contract AC05-84OT21400. From Spectrum 90 international topical meeting; Knoxville, TN (USA); 30 Sep - 4 oct 1990. Order Number DE90012737. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

One of the most common statements posed by public and government officials during the course of investigations at hazardous waste sites is, "Why does it take so long?" or "When are they going to clean up the site?" These are fair questions, particularly in light of the extended Remedial Investigation/Feasibility Study (RI/FS) and cleanup programs ongoing at Superfund sites across the country. Obviously there are many reasons why the investigations take so long. Regulatory requirements, public involvement, contracting requirements, and project scoping all play a major role in project longevity. This paper addressed two key areas that can accelerate field investigations: improved scoping techniques and a flexible field program that relies on real-time data acquisition and interpretation of on-site by a comprehensive team of project personnel. This paper is based on an approach that has been implemented as part of the remedial process at a federal facility National Priorities List site with 73 study areas and extensive soil and groundwater contamination.

41615 (DOE/BP–01830-6) **Hatchery Effectiveness Technical Work Group: Retreat proceedings.** Fickeisen, D.H.; Neitzel, D.A.; Dauble, D.D. Pacific Northwest Lab., Richland, WA (USA). Apr 1990. 37p. Sponsored by U.S. DOE Bonneville Power Administration. DOE Contract AC06-76RL01830. (CONF-9001105–Summ.: Hatchery effectiveness technical work group meeting (HETWG), Gleneden Beach, OR (USA), 9-11 Jan 1990). Order Number DE90014146. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This report summarizes a retreat held for the Hatchery Effectiveness Technical Work Group (HETWG). The objectives were to improve the effectiveness of the Technical Work Group (TWG) through developing procedures for its operation, and to develop and action plan for revision of their current research plan. The HETWG is one of five groups chartered by the Northwest Power Planning Council (NPPC) to provide expert technical advice on research needs related to the NPPC's goal of increasing anadromous fish runs in the Columbia River Basin. The HETWG is responsible for developing a five-year research plan to improve the effectiveness of existing anadromous fish hatcheries in the basin. The retreat was sponsored by the Bonneville Power Administration, who requested the assistance of the Pacific Northwest Laboratory to help plan and facilitate the meeting under an intraagency agreement. The retreat was held at Salishan Lodge in Gleneden Beach, Oregon, on January 9-11, 1990. The 10 members of the HETWG and several of their supervisors and invited observers were present. 4 refs., 2 figs.

41616 (DOE/BP–01830-7) **Proceedings of the anadromous fish release strategies workshop.** Neitzel, D.A. (Pacific Northwest Lab., Richland, WA (USA)); Fickeisen, D.H. USDOE Bonneville Power Administration, Portland, OR (USA). Div. of Fish and Wildlife; Pacific Northwest Lab., Richland, WA (USA). Jun 1990. 33p. Sponsored by U.S. DOE Bonneville Power Administration. DOE Contract AC06-76RL01830. (CONF-8912105–Summ.: Proceedings of the anadromous fish release strategies workshop, Eagle Creek, OR (USA), 11-14 Dec 1989). Order Number DE90014142. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

During 1987, the Hatchery Effectiveness Technical Work Group (HETWG) developed a work plan to define research that could improve the effectiveness of present hatchery programs in the Columbia River Basin. The objective of the Anadromous Fish Release workshop was to identify release strategies that would lead to improved survival of anadromous fish produced in Columbia River Basin hatcheries. The method used at the workshop was to review anadromous fish release strategies presently used, or proposed for use, at hatcheries and to consider new techniques. The workshop produced ranked research recommendations, a list of release practices to improve hatchery effectiveness, and general comments about hatchery effectiveness research. Research needs, current release practices, and general comments to prove hatchery effectiveness were identified by workshop participants. In this report, results of the workshop are presented in seven sections and three appendices. The sections include an introduction; discussions of current release strategies, research needs, release practices recommendations, and general comments; a list of workshop recommendations; and cited literature. The appendices identify membership in the HETWG, and list the workshop's invited scientists, participants, and workshop agenda. 2 refs.

41617 (DOE/BP/16726–5) **Influence of habitat modifications on habitat composition and anadromous salmonid populations in Fish Creek, Oregon, 1983–88: Annual report, 1988.** Reeves, G.H. (Forest Service, Corvallis, OR (USA). Pacific Northwest Range and Experiment Station); Everest, F.H.; Sedell, J.R.; Hohler, D.B. Forest Service, Corvallis, OR (USA). Pacific Northwest Range and Experiment Station; Mount Hood National Forest, Gresham, OR (USA). May 1990. 50p. Sponsored by U.S. DOE Management & Administration. DOE Contract AI79-84BP16726. Order Number DE90014143. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Modification of degraded habitats to increase populations of anadromous salmonids is a major focus of management agencies throughout the Pacific Northwest. Inherent in implementing habitat improvements is the need for quantitative evaluation of the biological and physical effects of such work. While it is not economically possible to thoroughly evaluate every habitat project, it is essential that intensive evaluations be done on selected representative projects. One such evaluation program has been underway since 1982 on Fish Creek, a tributary of the Clackamas River near Estacada, OR. Habitat modification has been done by the USDA Forest Service, Estacada Ranger District, Mt. Hood National Forest with funding provided in part by the Bonneville Power Administration (BPA). The USDA Forest Service, Anadromous Fish Habitat Research Unit, Pacific Northwest Research Station (PNW), Corvallis, OR is charged with: evaluating the biological and physical responses to habitat modifications on a basin scale; and developing a cost-benefit analysis of the program. The objectives of this paper are to: report 1988 observations of biological and physical changes in habitat, salmonid populations, and smolt production in Fish Creek, and examine preliminary trends in fish habitat and populations related to habitat improvement over the period 1983–1988. We have prefaced the trends in the latter objective as preliminary because we believe it could take a minimum of 10 years before the full biological and physical responses to habitat work are realized. 10 refs., 11 figs., 8 tabs.

41618 (DOE/BP/39638–5) **Evaluation of the contribution of fall chinook salmon reared at Columbia River hatcheries to the Pacific salmon fisheries: Appendix: Final report.** Vreeland, R.R. (National Marine Fisheries Service, Portland, OR (USA). Environmental and Technical Services Div.). USDOE Bonneville Power Administration, Portland, OR (USA). Div. of Fish and Wildlife; National Marine Fisheries Service, Portland, OR (USA). Environmental and Technical Services Div. Jun 1990. 498p. Sponsored by U.S. DOE Management & Administration. DOE Contract AI79-83BP39638. Order Number DE90014144. Available from NTIS, PC A21/MF A01 - OSTI; GPO Dep.

This document contains 43 appendices for the "Evaluation of the Contribution of Fall Chinook Salmon Reared at Columbia River Hatcheries to the Pacific Salmon Fisheries" report. This study was

initiated to determine the distribution, contribution, and value of artificially propagated fall Chinook Salmon from the Columbia River.

41619 (DP–1746) **An overview of the Savannah River Plant water quality database.** Price, V. Savannah River Lab., Aiken, SC (USA). Jun 1990. 22p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC09-89SR18035 ;AC09-76SR00001. Order Number DE90013624. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Over 900 partial or complete chemical analyses of ground water from the Savannah River Plant were examined. Computer screening techniques including factor and cluster analysis are useful in identifying trends and anomalous samples in the database. The data examined in this report are from a database of 1986 and 1987 quarterly monitoring results. Some deficiencies noted in this report are not relevant to more recent sampling. Electrochemical effects are noted as a potential complicating factor in interpreting ground-water analyses. It is recommended that studies be made of each monitoring well to confirm that routine sampling protocols yield water representative of the zone targeted for sampling. 5 refs., 5 figs., 3 tabs.

41620 (HW–64517) **Effect of proposed HAPO [Hanford Atomic Products Operation] reactor production increases on radioactivity discharged to the Columbia River.** Hall, R.B.; Jerman, P.C. General Electric Co., Richland, WA (USA). Hanford Atomic Products Operation. 29 Mar 1960. 7p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC06-76RL01830. Order Number DE90014018. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Declassified 11 September 1981.

The incentive to increase the production of the existing Hanford reactors is being examined. Increased reactor production will increase the radioactivity discharged to the Columbia River in reactor effluent water. It is the purpose of the document to evaluate the increased effluent problems which will result. Study of the production increases which are possible with present reactors indicate that the increase in effluent water activity could be as much as 50% increase for critical isotopes in Columbia River water at Pasco will still hold the concentration well below the non-occupational MPL for GI tract dose. A problem will exist for individuals who consume as a substantial part of their diet, whitefish and other bottom feeding fish of the Columbia River caught in the vicinity of the plant. It is conceivable that the body burden of P^{32} in a few individuals could exceed 125% of the non-occupational maximum permissible body burden specified in NBS Handbook 69. Laboratory scale tests of effluent water treatment in which the effluent is passed through a media of aluminum turnings before entering the river have indicated that the P^{32} concentration in effluent may be reduced by about 45%. 4 refs., 2 figs.

41621 (HW–69723) **Existing and proposed studies at HAPO [Hanford Atomic Products Operation] relating to the Columbia River.** Foster, R.F. General Electric Co., Richland, WA (USA). Hanford Atomic Products Operation. 24 May 1961. 16p. Sponsored by U.S. DOE Management & Administration. DOE Contract AC06-76RL01830. Order Number DE90014023. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This document was prepared in response to a request by the Hanford Operations Office of the Atomic Energy Commission for a statement of problems relating to the Columbia River. The Commission expressed particular interest in: research on such problems as the fate of radioelements released in reactor effluent; river flows, water temperatures and pH and the effect of Hanford Operations on these factors; dispersion of the effluent from the outfalls; surveys of the river for small areas of high temperature water; kinds and movement of sediments and their radioisotope adsorption characteristics; fish diseases and other water quality studies; and proposed work on plankton and aquatic insects. The Columbia River is of vital importance to the Hanford Plant as a source of process water, as a heat sink, and as a dispersing medium for the radioactive materials discharged with the reactor effluent. A variety of studies have been undertaken by various organizational components at Hanford in order to maximize reactor operation, optimize water treatment, minimize the discharge of radioactive materials, trace the dispersion of the effluent, determine the fate of the radioactive contaminants in the environment, evaluate the potential exposure to persons utilizing the river downstream, evaluate the impact of the effluent on aquatic life of the river, and utilize the radionuclides as tracers to gain basic knowledge of physical, chemical and biological phenomena in the river environment.

41622 (HW–70937) **Reduction of radioisotopes in reactor effluent water.** Hall, R.B. General Electric Co., Richland, WA (USA). Hanford Atomic Products Operation. 5 Sep 1961. 28p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC06-76RL01830. Order Number DE90014017. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Declassified 16 October 1989.

The first full scale attempts to control the release of radioisotopes in Hanford reactor effluent water into the Columbia River are described in this document. The effects of reactor effluent release were carefully and extensively monitored for many years. Until recently the results of this monitoring did not seem to justify effluent activity control. Through simple modification of the reactor cooling water treatment process, effective control was demonstrated and significant reduction in activity release was achieved for those radioisotopes which contribute most to the radiation exposure to individuals off plant. Whereas reduction of P^{32} concentrations in reactor effluent water exceeded expectations, reduction of As^{76} was not as great as earlier tests would indicate. Some reduction in the concentrations of Zn^{65}, N^{239}, and Cr^{51} were also achieved. 5 refs., 22 figs.

41623 (HW–71718) **Effect of high alum feed on the release of P^{32} to the Columbia River.** Hall, R.B. General Electric Co., Richland, WA (USA). Hanford Atomic Products Operation. 9 Nov 1961. 9p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC06-76RL01830. Order Number DE90014021. Available from NTIS, PC A02/MF A01 - OSTI.

Declassified 31 October 1989.

This document relates the progress of reactor effluent activity control through the use of higher than normal alum feed rates. It is intended to describe the actual experience with the process and some of the areas where further effort would be beneficial. The emphasis to date has been placed on the reduction of the release of phosphorus-32 because of its significance to environmental exposure estimates and because of the seasonal nature of exposure received from it. Experience has shown that seven of the eight reactors achieved a reduction approaching an order of magnitude and that at one reactor this reduction was maintained almost throughout a three month period. 3 refs., 3 figs., 1 tab.

41624 (KAPL–4714) **Knolls Atomic Power Laboratory annual environmental monitoring report: Calendar year 1989.** Knolls Atomic Power Lab., Schenectady, NY (USA). [1989]. 106p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC12-76SN00052. Order Number DE90014346. Available from NTIS, PC A06/MF A01; OSTI; INIS; GPO Dep.

The results of the effluent and environmental monitoring programs at the three Knolls Atomic Power Laboratory (KAPL) sites are summarized and assessed in this report. The effluent and environmental monitoring programs conducted by KAPL are designed to determine the effectiveness of treatment and control methods, to provide measurement of the concentrations in effluents for comparison with applicable standards, and to assess resultant concentrations in the environment. The monitoring programs include analyses of samples of liquid and gaseous effluents for chemical constituents and radioactivity as well as monitoring of environmental air, water, sediment, and fish. Radiation measurements are also made around the perimeter of each site and at off-site background locations. KAPL environmental controls are subject to applicable state and federal regulations governing use, emission, treatment, storage and/or disposal of solid, liquid and gaseous materials. Chemicals are not manufactured or disposed of at KAPL but are used incidental to site operations. Those substances characterized as hazardous by the EPA are controlled through administrative procedures and personnel training. Handling and storage incidental to shipment of wastes are controlled and monitored by trained personnel in compliance with applicable EPA regulations. Accountability and radiation survey procedures are used at each KAPL site

for the handling, packaging, and transportation of all radioactive materials. KAPL is in full compliance with DOE and EPA exposure standards governing the release of radioactivity to the environment. 42 refs., 14 figs., 46 tabs.

41625 (MAFF-FRDR–22) **Investigation of external radiation exposure pathways in the eastern Irish Sea, 1989.** Doddington, T.C.; Camplin, W.C.; Caldwell, P. Ministry of Agriculture, Fisheries and Food, Lowestoft (UK). Directorate of Fisheries Research. 1990. 30p. Order Number DE90633618. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

External exposure pathways were investigated in 1989, along the coastline from Rockcliffe in north Cumbria to the River Mersey. The survey involved four main periods of field work, when individuals and representatives of organisations were interviewed to establish time spent in recreational and occupational activities over intertidal areas. Data on seafood consumption rates were also collected. Gamma dose rate measurements were made to supplement routine monitoring operated by the Directorate of Fisheries Research. The critical group for external exposure was established as being those living on houseboats in the Ribble estuary. Their effective dose equivalent was assessed at 0.17 mSv in 1989, equivalent to an occupancy of 3000 h year^{1} over unshielded mud. Succeeding high doses were found to be due to activities in the Wyre and Ravenglass estuaries and Whitehaven harbour. Locations where higher doses were found were few and far between and the majority of exposures were lower than 0.01 mSv. (author).

41626 (PB–90-208331/XAB) **Health assessment for Anne Arundel County Landfill, Glen Burnie, Maryland, Region 3. CERCLIS No. MDD980705057. Preliminary report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 31 Jan 1990. 12p. Available from NTIS, PC A03/MF A01.

The Anne Arundel County Landfill (AACL) has been proposed for inclusion on the National Priorities List (NPL) of the U.S. Environmental Protection Agency (EPA). The 130-acre site is located in Glen Burnie in Anne Arundel County, Maryland. The onsite shallow groundwater aquifer (25 to 60 feet) contained heavy metals (arsenic and lead) and volatile organic compounds (1,1-dichloroethane, 1,1-dichloroethene, trans-1,2-dichloroethane, 1,1,1-trichloroethane, trichloroethylene, and vinyl chloride) at concentrations significantly above the MCLs, and PMCLGs. Inorganic compounds were not at concentrations of health concern in the deep groundwater aquifer (100 to 150 feet). However, some volatile organic compounds (1,1-dichloroethane, 1,1-dichloroethylene, 1,1,1-trichloroethane) were detected, and trichloroethylene was found at concentrations exceeding the MCL in two wells on site in the southwest quadrant. The site is considered to be of potential public health concern because of the potential risk to human health resulting from possible exposure to hazardous substances.

41627 (PB–90-208356/XAB) **Health assessment for Cedartown Industries, Cedartown, Polk County, Georgia, Region 4. CERCLIS No. GAD95840674. Preliminary report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 29 Jan 1990. 10p. Available from NTIS, PC A02/MF A01.

The Cedartown Industries, Inc. site has been proposed for the National Priorities List (NPL) by the U.S. Environmental Protection Agency (EPA). The 7-acre site is located in Cedartown, Polk County, Georgia, in the northwest part of the State. In 1986, one sediment sample from an on-site impoundment and two soil samples (one background) were collected on-site and analyzed by EPD. Only Extraction Procedure (EP) Toxicity testing was performed on these samples. The test which measures the concentration of leachate generated from the soil showed leachate with lead concentrations up to 720 parts per million (ppm) and cadmium concentrations up to 1.4 ppm. Based on the information reviewed, ATSDR has concluded that the site is of potential public health concern because humans may be exposed to hazardous substances at concentrations that may result in adverse health effects. As noted in the Human Exposure Pathways Section above, human exposure to lead may occur via ingestion of, inhalation of, and dermal contact with surface water, sediments, soils, ground water, air, and food-chain entities.

41628 (PB–90-208372/XAB) **Health assessment for Kaiser Steel Corporation Fontana, San Nernadino County, California, Region 9. CERCLIS No. CAD008274938. Preliminary report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 25 Oct 1989. 15p. Available from NTIS, PC A03/MF A01.

The Kaiser Steel Corporation (KSC) site was included in the Update 7, proposed National Priorities List (NPL). The site was subsequently dropped from the proposed NPL on October 4, 1989. The site is located near Fontana, California, in San Bernardino County, approximately 45 miles east of Los Angeles. The on-site environmental contamination in groundwater and soil consisted of volatile organic compounds, organic acids, aluminum, barium, iron, lead, manganese, cadmium, and chromium compounds. The site is of potential health concern because of the risk to human health resulting from possible exposure to hazardous substances at concentrations that may result in adverse health effects.

41629 (PB–90-208380/XAB) **Health assessment for Lehigh Portland Cement Company, Mason City, Cerro Gordo County, Iowa, Region 10. CERCLIS No. IAD005288634. Preliminary report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 29 Aug 1989. 15p. Available from NTIS, PC A03/MF A01.

The Lehigh Portland Cement Company Site is listed by the U.S. Environmental Protection Agency (EPA) on the National Priorities List (NPL). The site consists of approximately 150 acres and is located in the west side of U.S. Highway 65, in the northern section of Mason City, Cerro Gordo County, Iowa. Seven groundwater samples were analyzed together with 1 field blank (E&E/FIT). No significant levels of contaminants were found in the private wells except for sodium (23 mg/1) from one residential well of unknown depth. The contaminants of concern are: arsenic, cadmium, lead, sodium, and sulfates. The site is considered to be of public health concern because of the risk resulting from potential exposure to hazardous substances via soil, surface water, groundwater and air.

41630 (PB–90-208398/XAB) **Health assessment for Northwestern States Portland Cement Company, Mason City, Cerro Gordo County, Iowa, Region 10. CERCLIS No. IAD980852461. Preliminary report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 29 Aug 1989. 16p. Available from NTIS, PC A03/MF A01.

The West Quarry Site/Northwestern States Portland Cement Company is listed by the U.S. Environmental Protection Agency (EPA) on the National Priority Lists (NPL). The site is a 150-acre old abandoned quarry (including kiln dust deposits and the flooded portion which contains contaminated water), located in the western portion of approximately 250 acres of land owned by the Northwestern States Portland Cement Company. Ten monitoring wells were installed at various locations surrounding the site at depths ranging from 14 to 60.6 feet; wells north of the site were located between the pond and Calmus Creek. In July 1987, 1 groundwater sample from each monitoring well, was analyzed for sulfates, total metals, dissolved metals and pH (E&E/FIT). Arsenic and lead were quantitatively identified in some of the samples. The site is considered to be of public health concern because of the risk to human health resulting from potential exposure to hazardous substances via soil, surface water, groundwater, and air.

41631 (PB–90-212549/XAB) **Direct/delayed response project: Field operations and quality-assurance report for additional watershed mapping in the northeastern region of the United States.** Kern, J.S.; Lammers, D.A.; Cassell, D.L.; Campbell, W.G. NSI Technology Services Corp., Corvallis, OR (USA). May 1990. 180p. Available from NTIS, PC A09/MF A01.

The report documents the second (additional) mapping program of the Direct/Delayed Response Project (DDRP) in the Northeastern United States. The survey of additional watersheds was conducted because of apparent sulfate retention by some watersheds based on data from the original DDRP Northeastern survey. The objectives of the report are to document the methods, field operations, and quality assurance/quality control (QA/QC) of the mapping. The protocols, QA plan, and soil legend for the watershed mapping are presented as appendices.

41632 (PB–90-216276/XAB) **Microbial degradation of nitrogen, oxygen, and sulfur heterocyclic compounds under anaerobic conditions: Studies with aquifer samples.** Kuhn, E.P.; Suflita, J.M. Oklahoma Univ., Norman, OK (USA). Dept. of Botany and Microbiology. ©1989. 12p. Available from NTIS, PC A03/MF A01.

Pub. in Environmental Toxicology and Chemistry, Vol. 8, No. 12, 1149-1158(Dec 1989).

The potential for anaerobic biodegradation of 12 heterocyclic model compounds was studied. Nine of the model compounds were biotransformed in aquifer slurries under sulfate-reducing or methanogenic conditions. The nitrogen and oxygen heterocyclic compounds were more susceptible to anaerobic biodegradation than those compounds containing a sulfur deteroatom. In contrast, only small amounts of methane were detected in aquifer slurries amended with compounds containing an oxygen heteroatom, even though a decrease in the parent substrate concentration occurred. Pyridine, 2-picoline and 4-picoline were biotransformed within three months under sulfate-reducing conditions. However, longer incubation times were required for the degradation of these substrates in methanogenic aquifer slurries. A literature survey reveals the widespread contamination of ground waters with heterocyclic compounds from waste management practice and fossil-fuel-related industries.

41633 (PB–90-216284/XAB) **Abiotic dehalogenation of 1,2-dichloroethane and 1,2-dibromoethane in aqueous solution containing hydrogen sulfide.** Barbash, J.E.; Reinhard, M. Stanford Univ., CA (USA). Dept. of Civil Engineering. ©1989. 12p. Available from NTIS, PC A03/MF A01.

Pub. in Environmental Science and Technology, Vol. 23, No. 11, 1349-1358(Nov 1989).

The detection of significant levels of halogenated aliphatic contaminants in groundwater resources in the United States has spurred a considerable effort to understand the various mechanisms–both microbiological and abiotic–by which these compounds may be transformed. In aerobic environments, the abiotic reactions that predominate are elimination of hydrogen halide (dehydrohalogenation) and nucleophilic substitution by H_2O (hydrolysis). Little research has examined the rates and pathways of abiotic reactions that may be significant under hypoxic conditions. The dehalogenation of 1,2-dichloroethane (1,2-DCA) and 1,2-dibromoethane (EDB) in phosphate buffer was examined alone, and in phosphate buffer containing hydrogen sulfide. Kinetic runs were conducted at pH 7 over the temperature range from 25 to 87.5 C. Phosphate buffer catalyzed the hydrolysis of both 1,2-SCA and EDB. This catalysis was attributed to the buffer anion HPO4(2-). The rate laws for these transformations exhibit the following form: $-d(RX)/dt=(K^1_H) + K_{HS-}(HS^-) + K_{HPO4(2-)}(HPO4(2-))(RX)$ where RX denotes either 1,2-DCA or EDB, and the rate constants correspond to the overall reactions.

41634 (PB–90-216300/XAB) **Identifying vulnerable surface water utilities.** Clark, R.M.; Grayman, W.M.; Males, R.M.; Kilgore, R. Environmental Protection Agency, Cincinnati, OH (USA). Water Engineering Research Lab. ©1989. 10p. (EPA–600/J-89/357). Available from NTIS, PC A02/MF A01.

Although industrial discharges from point sources are regulated by the Federal Water Pollution Control Acts, National Pollutant Discharge Elimination System (NPDES), some toxic pollutants continue to be discharged into surface waters. Frequently these same surface waters are major sources of drinking water. The Safe Drinking Water Act Amendments have specified a large number of new contaminant levels, (MCLs) at the microgram per liter level. It is possible that many water utilities finding that these new MCLs are violated will seek to identify upstream dischargers and request that regulatory agencies force them to install discharge controls rather than pay for expensive water treatment processes. The study reported in the paper documents the development of a data base management system and a water quality modeling approach that allows drinking water utilities to assess the impact of these upstream discharges on raw water quality. The report makes recommendations to USEPA for modifying its NPDES procedures.

41635 (PB–90-216383/XAB) **Regional relationships between geomorphic/hydrologic parameters and surface water chemistry relative to acidic deposition.** Rochelle, B.P.; Liff, C.I.; Campbell, W.G.; Cassell, D.L.; Church, M.R. Environmental Protection Agency, Corvallis, OR (USA). Environmental Research Lab. ©1989. 20p. (EPA–600/J-89/348). Available from NTIS, PC A03/MF A01.

Pub. in Jnl. of Hydrology, Vol. 112, 103-120(1989).

The authors determined geomorphic and hydrologic parameters for 144 forested, lake watersheds in the Northeast (NE) of the United States based primarily on measurements from topographic maps. These parameters were used to test for relationships with selected surface water chemistry relevant to acidic deposition. Analyses were conducted on regional and subregional scales delineated based on soils, land use, physiography, total sulfur deposition and statistical clustering of selected geomorphic/hydrologic parameters. Significant relationships were found among the geomorphic/hydrologic parameters and the surface water chemistry for the NE. Elevation had the most significant relationship with surface water chemistry, particularly in the mountainous areas of the NE. Other factors occurring consistently as significant predictors of surface water chemistry were maximum relief, relief ratio, runoff, and estimates of basin elongation. Results suggest that elevational parameters might be surrogates for other watershed characteristics, such as soils or spatial deposition patterns.

41636 (PB–90-216458/XAB) **Direct/Delayed Response Project: Field operations and quality-assurance report for watershed mapping in the Mid-Appalachian region of the United States.** Kern, J.S.; Lammers, D.A.; Cassell, D.L.; Campbell, W.G. NSI Technology Services Corp., Corvallis, OR (USA). May 1990. 175p. Available from NTIS, PC A08/MF A01.

The report documents the mapping program of the Direct/Delayed Response Project in the Mid-Appalachian Region of the United States. The objectives of the report is to document the planning activities, field operations, and quality assurance/quality control (QA/QC) of the mapping. The protocols, QA plan, and soil legend for the watershed mapping are presented as appendices.

41637 (PB–90-216524/XAB) **Proximity of sanitary landfills to wetlands and deepwater habitats: An evaluation and comparison of 1,153 sanitary landfills in 11 states.** Lambou, V.W.; Kuperberg, J.M.; Moerlins, J.E.; Herndon, R.C.; Gebhard, R.L. Environmental Protection Agency, Las Vegas, NV (USA). Environmental Monitoring Systems Lab. May 1990. 79p. (EPA–600/4-90/012). Available from NTIS, PC A05/MF A01.

Sanitary landfills can cause considerable harm to sensitive ecosystems if they are not properly located, designed, and managed. The purpose of the report is to evaluate and compare the proximity of 1,153 sanitary landfills in 11 states (Connecticut, Delaware, Florida, Georgia, Louisiana, New Jersey, New York, North Carolina, Pennsylvania, Texas, and Washington) to wetlands and deepwater habitats (i.e., rivers, lakes, streams, bays, etc.). The nearness or proximity of the sanitary landfills to wetlands and deepwater habitats was determined by drawing three concentric regions around the point representing the location of each landfill. The radii of the concentric regions were: 1/4 mile, 1/2 mile, and 1 mile. Almost all of the sanitary landfills are located in or are close to either wetlands or deepwater habitats.

41638 (PB–90-217191/XAB) **Selection of candidate streams for acid mitigation in western Maryland. Final report.** Bonoff, M.; Janicki, A.; Cooper, C. International Science and Technology, Inc., Sterling, VA (USA). Oct 1989. 27p. Available from NTIS, PC A03/MF A01.

An evaluation of a series of potential candidate streams and application of acid mitigation techniques was conducted. The populations of candidate streams was those streams from the Maryland Synoptic Stream Chemistry Survey with acid neutralizing capacity less than 110 microeq/L. The land use characteristics of those streams were screened to eliminate those streams potentially affected by urbanization, agricultural development, or mining. The evaluation of the remaining sites was conducted using topographic maps to determine the relative ease of access to the sites. A total of 22 suitable candidate streams were identified. The areas of the watersheds surrounding each of these reaches were all less than

10 sq km. The pH of the 22 candidate reaches ranged from 3.16 to 6.92. Given the accessibility of the candidate sites, both automated dosers and watershed applications are reasonable treatment alternatives.

41639 (PB–90-217217/XAB) **Massachusetts Water Resources Research Center annual program report, 1989.** Godfrey, P.J. Massachusetts Univ., Amherst, MA (USA). Water Resources Research Center. Mar 1990. 46p. Available from NTIS, PC A03/MF A01.

See also PB–89-162283.

The projects included are: Denitrification System for On-Site Wastewater Treatment; Acidity and Chemistry of Clouds and Fog in Central Massachusetts; Development of a Water-Supply Decision-Making Model Incorporating the Long-Run Cost of Water; the Acid Rain Monitoring Project (A.R.M.), Phase 2; Stimulation of Mercury Methylation by Acid Deposition; and Surface Water Supplies at Risk to Acid Deposition in Massachusetts.

41640 (PB–90-217381/XAB) **Hexachlorobenzene uptake by fathead minnows and macroinvertebrates in recirculating sediment/water systems.** Schuytema, G.S.; Krawczyk, D.F.; Griffis, W.L.; Nebeker, A.V.; Robideaux, M.L. Environmental Protection Agency, Corvallis, OR (USA). Environmental Research Lab. ©1990. 11p. (EPA–600/J-90/006). Available from NTIS, PC A03/MF A01.

Pub. in Archives of Environmental Contamination and Toxicology, Vol. 19, 1-9(1990).

Fathead minnow (Pimephales promelas), the worm, Lumbriculus variegatus, and the amphipods Hyalella azteca and Gammarus lacustris were exposed to hexachlorobenzene (HCB) in water with and without a bed of HCB-spiked sediment. Water HCB concentrations were maintained by recirculation through HCB-packed columns. Recirculating HCB-bound particulates and possibly eroded HCB particulates were an added source of HCB in addition to the sediment bed. Significant bioaccumulation of HCB in animal tissues was observed in water-only and water-sediment exposures. The presence of the HCB-spiked sediment did not result in a significant increase in the uptake of HCB by the organisms, but there was a substantial increase in sediment HCB levels over time. Higher tissue HCB levels in aquaria without sediment suggest that the sediment was a more efficient sink for HCB than the organisms.

41641 (PB–90-217621/XAB) **Site demonstration of the CHEMFIX solidification/stabilization process at the Portable Equipment Salvage Company site.** Barth, E.F. Environmental Protection Agency, Cincinnati, OH (USA). Risk Reduction Engineering Lab. ©1990. 7p. (EPA–600/J-90/021). Available from NTIS, PC A02/MF A01.

Pub. in Jnl. of the Air and Waste Management Association, 166-170(1990).

A demonstration of the CHEMFIX solidification/stabilization process was conducted under the United States Environmental Protection Agency's (EPA) Superfund Innovative Technology Evaluation (SITE) program. The demonstration was conducted in March 1989, at the Portable Equipment Salvage Company (PESC) uncontrolled hazardous waste site in Clackamas, Oregon. Waste containing lead, copper, and polychlorinated biphenyls (PCBs) from four different areas of the site were treated. Results showed substantial reduction of leachable lead and copper between the untreated waste and treated waste utilizing the EPA Toxicity Characteristics Leaching Procedure (TCLP) test. The effectiveness of this process for immobilizing PCBs could not be determined since the raw waste did not leach PCBs at high concentrations, utilizing the TCLP test. Data from other leaching tests for lead and copper would need to be utilized as input into a site specific groundwater model to determine whether solidification/stabilization would be an acceptable remedy for the site. Physical testing results indicated durability in exposed conditions.

41642 (PB–90-219049/XAB) **Bellingham Bay action program: Initial data summaries and problem identification.** Decker, D.S.; Sonnerup, R.; Greene, J.J. PTI Environmental Services, Bellevue, WA (USA). Aug 1989. 330p. Available from NTIS, PC A15/MF A02.

See also PB–84-218122. Portions of this document are not fully legible.

The report provides a synthesis of information describing the geographic extent and severity of estuarine contamination in Bellingham Bay within Puget Sound in Washington State. Summaries of existing data are provided for chemical contamination of sediment and biota, microbial contamination, eutrophication and contaminant sources. Original, summarized, tabulated, and mapped data are presented. The objective of the report is to provide a mechanism for comprehensively evaluating pollution problems in the more urbanized embayments and for providing a basis for prioritizing corrective actions. A decision making framework is presented for evaluating and prioritizing both sub-areas within Bellingham Bay and specific contaminant sources.

41643 (PB–90-219064/XAB) **Elliott Bay action program: Analysis of toxic problem areas. Puget Sound estuary program. Final report and appendices. Two volumes. Final report.** PTI Environmental Services, Bellevue, WA (USA). Jul 1988. 624p. Available from NTIS, PC A99/MF A04.

See also PB–90-197898.

The report presents the results of a field investigation of the nearshore region of the Elliot Bay/Duwamish River system, in Seattle. Under the Elliott Bay Urban Action Program, federal, state, and local agencies cooperate to respond to toxic contamination problems. Response actions may include regulatory control of point and non-point contamination sources, source treatment, capping or removal of highly contaminated sediments. The study objectives were to: (1) define spatial patterns and quantitative relationships between sediment contamination, toxicity and biological effects; (2) identify problem areas of sediment contamination; (3) rank problem areas for possible remediation; (4) identify potential problem chemicals that display high concentrations in association with biological effects. A standardized assessment technique used in several other Puget Sound Estuary Program urban bay projects was used to identify problem sediments.

41644 (PB–90-219072/XAB) **Everett Harbor action program: Evaluation of potential contaminant sources. Puget Sound estuary program. Final report.** Tetra Tech, Inc., Bellevue, WA (USA). Sep 1988. 256p. Available from NTIS, PC A12/MF A02.

See also PB–84-218122.

The Puget Sound Urban Bay Action Program for Everett Harbor was initiated in 1985 by the U.S. Environmental Protection Agency, the Washington State Department of Ecology and other resource management agencies. Its purpose is to identify and control toxic contamination in the Port Gardner and lower Snohomish River areas of the harbor. The document reports the results of source sampling efforts. The potential sources reviewed included: industrial facilities, wastewater treatment plants, combined sewer overflows, landfills, surface runoff pathways, groundwater, atmospheric deposition and spills. The source sampling program was designed as an initial screening survey that would identify problem chemicals in a limited number of sediments from drains discharging into Port Gardner and in groundwater samples from three monitoring wells at the Mukilteo Defense Fuel Supply Depot. More extensive sampling is needed before potential sources can be properly ranked for further investigation and control.

41645 (PB–90-219320/XAB) **Relationship of human levels of lead and cadmium to the consumption of fish caught in and around Lake Coeur d'Alene, Idaho. Final report.** Richter, B.S.; Rondinelli, R. Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). Sep 1989. 80p. (ATSDR/HS–90/08). Available from NTIS, PC A05/MF A01.

A pilot exposure study was conducted to determine whether the consumption of fish captured in Lake Coeur d'Alene (LCD), the Coeur d'Alene River, and the adjacent Chain Lakes, could substantially increase lead and cadmium levels in human blood and urine. The goals of the study were: to characterize fish and duck consumption patterns of people living around LCD; and to determine the association between fish and duck consumption and lead/cadmium levels. The lead and cadmium levels among participants living near LCD were within the expected range and are not of any known clinical importance. After adjusting for age and smoking, it was found that persons eating fish or duck were more likely to have higher than the median levels of cadmium in their urine. There were no statistically significant associations between fish or

duck consumption and blood levels of lead or cadmium or urine levels of cadmium when adjusted for creatinine.

41646 (PB–90-219395/XAB) **Direct/Delayed Response Project: Quality-assurance report for physical and chemical analyses of soils from the northeastern United States.** Byers, G.E.; Van Remortel, R.D.; Teberg, J.E.; Miah, M.J.; Palmer, C.J. Lockheed Engineering and Sciences Co., Inc., Las Vegas, NV (USA). Nov 1989. 244p. Available from NTIS, PC A11/MF A02.

The Northeastern Soil Survey was conducted during 1985 as a synoptic physical and chemical survey to characterize a statistical sampling of watersheds in a region of the United States believed to be susceptible to the effects of acidic deposition. The document addresses the implementation of a quality assurance program and the verification of the analytical data base for the Northeastern Soil Survey. It is focused primarily towards the users of the data base who will be analyzing the data and making various assessments and conclusions relating to the effects of acidic deposition on the soils of the Northeastern region of the United States. Verification procedures used to analyze laboratory data are described. Quality is assessed by describing the detectability, precision, accuracy (interlaboratory differences), representativeness, completeness, and comparability of the data for the quality assurance samples used throughout the soil survey.

41647 (PB–90-219650/XAB) **Acquisition and analysis of groundwater/aquifer samples: Current technology and the trade off between quality assurance and practical considerations.** Loux, N.T.; Garrison, A.W.; Chafin, C.R. Environmental Protection Agency, Athens, GA (USA). Environmental Research Lab. ©1990. 25p. (EPA–600/J-90/027). Available from NTIS, PC A03/MF A01.

Pub. in International Jnl. of Environmental Analytical Chemistry, Vol. 38, No. 3, 231-253(1990).

In the migration of a high-organic-carbon-content landfill leachate through the subsurface environment, the mobility of inorganic contaminants can be seriously influenced by oxidation-reduction, complexation, precipitation and adsorption processes. These processes, in turn, depend on the dissolved major (and minor) element composition, dissolved gas content, degree of equilibrium and the nature of the aquifer surfaces exposed to groundwater. Groundwater, aquifer material and municipal landfill leachate samples were collected from various locations within the continental United States. These samples were characterized in terms of elemental composition, pH, Eh, dissolved gases and solid phase characteristics (Specific Surface Area, CEC, extractable amorphous components, identifiable crystalline components, etc.). Batch distribution behavior studies were performed with these samples with 14 potential metals and metaloids of concern to the EPA. Of more interest to the analytical chemist, however, are the manifold sampling, analytical and interpretative problems encountered: (1) What are the major sources of error in terms of the necessary expertise and equipment for sample acquisition. (2) Can samples be collected in an unperturbed manner and what is the best method to collect them. (3) How meaningful are field pH, Eh, dissolved oxygen and alkalinity measurements. How stable are these values. (4) Are current procedures sufficient for modeling attenuation processes.

41648 (PB–90-220526/XAB) **Superfund Record of Decision (EPA Region 8): East Helena, MT. (First remedial action), November 1989.** Environmental Protection Agency, Washington, DC (USA). Office of Emergency and Remedial Response. 22 Nov 1989. 190p. (EPA/ROD/R–08-90/027). Available from NTIS, PC A09/MF A01.

The 80-acre East Helena site, in East Helena, Lewis and Clark County, Montana, is a primary lead smelting facility that has been in operation since 1888. Prickly Pear Creek flows near the site and has been found to contain elevated levels of arsenic and lead. A 1984 remedial investigation identified elevated levels of metal contamination in soil, livestock, plants, and ground and surface waters with the sources of onsite contamination being primary and fugitive emissions and seepage from process ponds and process fluid circuitry. The primary contaminants of concern in the process ponds are metals including arsenic and lead. The selected remedial action for this site includes excavating and smelting 55,150 cubic yards of soil and/or sediment from all four process ponds and multi-media monitoring after individual remedial activities are implemented at three of the process pond areas.

41649 (PB–90-220534/XAB) **Superfund Record of Decision (EPA Region 9): Nineteenth Avenue Landfill, Phoenix, AZ. (First remedial action), September 1989. Final report.** Environmental Protection Agency, Washington, DC (USA). Office of Emergency and Remedial Response. 29 Sep 1989. 433p. (EPA/ROD/R–09-89/042). Available from NTIS, PC A19/MF A03.

The 213-acre Nineteenth Avenue Landfill is in an industrial area of Maricopa County, Phoenix, Arizona. State permitted landfill operations were conducted from 1957 to 1979 during which time approximately nine million cubic yards of municipal refuse, solid and liquid industrial wastes, and some medical wastes and materials containing low levels of radioactivity were deposited in the landfill. The State ordered the landfill closed in 1979 due to the periodic inundation of the landfill by flood waters from the Salt River Channel. Subsequently, the city covered the site with fill, stockpiled soil for final capping, installed ground water monitoring wells, built berms around the landfill, and installed a methane gas collection system. The remedial action is designed to mitigate threats resulting from flooding of the landfill, which has occurred intermittently since 1965. The primary contaminants of concern in the soil/refuse include VOCs such as toluene and xylenes.

41650 (PB–90-220633/XAB) **Superfund Record of Decision (EPA Region 6): Hardage/Criner Site, McClain County, Oklahoma (First remedial action, amendment), November 1989.** Environmental Protection Agency, Washington, DC (USA). Office of Emergency and Remedial Response. 22 Nov 1989. 246p. (EPA/ROD/R–06-90/054). Available from NTIS, PC A11/MF A02.

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The Hardage/Criner site is in an agricultural area near Criner, McClain County, in central Oklahoma. The site is situated in the North Criner Creek drainage basin. From 1972 to 1980 the site was operated under a State permit for the disposal of industrial wastes including paint sludges and solids, ink solvents, tire manufacturing wastes, oils, other solvents, cyanides, and plating wastes sludges. Waste disposal practices have resulted in the contamination of approximately 70 acres of ground water. A 1986 Record of Decision was never implemented due to protracted litigation. The 1989 ROD Amendment provides a comprehensive site remedy addressing both source control and ground water remediation and takes into consideration recently enacted land disposal restrictions. Source control remediation includes installation of liquid extraction wells to pump out free liquids currently pooled in the three waste areas and any liquids released from drums buried in the mounds, followed by offsite treatment.

41651 (PB–90-220641/XAB) **Superfund Record of Decision (EPA Region 3): Greenwood Chemical Site, Albemarle County, Newtown, Virginia (First remedial action), December 1989.** Environmental Protection Agency, Washington, DC (USA). Office of Emergency and Remedial Response. 29 Dec 1989. 64p. (EPA/ROD/R–03-90/084). Available from NTIS, PC A04/MF A01.

Portions of this document are not fully legible.

The five-acre Greenwood Chemical site is a former chemical plant in Newton, Virginia. Ground water is used by all persons within a three-mile radius for drinking water purposes. The chemical plant was used primarily for the production of industrial, pesticide, pharmaceutical, and photographic products from 1947 until 1985, and produced waste solvents including listed RCRA F002 and F005 wastes. Contaminated areas at the site include seven lagoons used to store wastewaters generated during plant operations, and a buried drum area. This operable unit addresses approximately 1.5 acres of the most contaminated portions of the site including the contaminated soil associated with three of the former lagoons, a backfilled lagoon now referred to as the backfilled area, and contained chemicals in the buildings. The selected remedial action for this operable unit includes excavation and offsite incineration of approximately 4,500 cubic yards of contaminated soil, backfilling with clean soil, and revegetating.

41652 (PB–90-220658/XAB) **Superfund Record of Decision (EPA Region 9): Firestone Tire and Rubber Company, Inc. site,**

Salinas, California (First remedial action), September 1989. Final report. Environmental Protection Agency, Washington, DC (USA). Office of Emergency and Remedial Response. 13 Sep 1989. 333p. (EPA/ROD/R-09-89/039). Available from NTIS, PC A15/MF A02.

Portions of this document are not fully legible.

The 256-acre Firestone Tire (Salinas Plant) site is in an agricultural area in Salinas, California. The facility was operated as a tire-manufacturing plant from 1963 to 1980, in which a variety of chemicals and chemical formulations were used including solvents and surfactants. In 1983, as part of the requirements for the closure of a RCRA-regulated storage area at the facility, Firestone conducted an environmental investigation and determined that some chemicals had been released to the soil and ground water. The final remedy provides for additional cleanup of ground water under the site and as much as 2 1/2 miles from the site. The primary contaminants of concern affecting the ground water are VOCs including 1,1-DCA, 1,1-DCE, 1,1,1-TCA, TCE, PCE, benzene, toluene, and xylenes. The selected remedial action for the site includes pumping and treatment of ground water.

41653 (PB-90-225582/XAB) **Health assessment for Cleveland Mill Site, Silver City, Grant County, New Mexico, Region 6. CERCLIS No. NMD981155930. Preliminary report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). 9 May 1990. 15p. Available from NTIS, PC A03/MF A01.

In compliance with the Comprehensive Environmental Response, Compensation, and Liability Act and the Resource Conservation and Recovery Act, as amended, the Agency for Toxic Substances and Disease Registry (ATSDR) has prepared Health Assessment reports for sites currently on, or proposed for, the National Priorities List (NPL). Health Assessments are also prepared for non-NPL sites in response to requests from States and individuals. In the report, the presence and nature of health hazards at this site are assessed, and the public health implications specific to this site are evaluated. The Health Assessment is based on such factors as the nature, concentration, toxicity, and extent of contamination at the site; the existence of potential pathways for the human exposure; the size and nature of the community likely to be exposed; and any other information available to ATSDR that is relevant to a determination of potential risks to public health. Additional Health Assessments may be conducted for this site as more information becomes available to ATSDR. The results of a Health Assessment are essential for determining the need to conduct health effects studies at a particular site.

41654 (PB-90-229261/XAB) **Sources of acidity in Maryland coastal plain streams. Final report.** Janicki, A.; Bonoff, M.; Lynch, J.; Morgan, M.; Thornton, K. Coastal Environmental Services, Inc., Linthicum, MD (USA). Feb 1990. 68p. Available from NTIS, PC A04/MF A01.

The study examined potential sources of acidity in Maryland Coastal Plain streams sampled during the Maryland Synoptic Stream Chemistry Survey. An analytical framework was developed to partition the potential anthropogenic contributions to stream acidity, and to examine the influence of land use, geology, and soils on stream chemistry. A model which used acid neutralizing capacity (ANC) and conductivity to classify 181 Coastal Plain streams was employed. The streams were classified into four groups: Group 1: low ANC, low conductivity; Group 2: high ANC, low conductivity; Group 3: high ANC, high conductivity; Group 4: low ANC, high conductivity. A discriminant analysis was used to test whether watershed characteristics alone could verify the a priori classification based on ANC and conductivity. The results from the analysis indicate that geology, soils, and land use data can be used to predict ANC and conductivity with a relatively high degree of certainty.

41655 (PB-90-869009/XAB) **Ground-water movement: Finite-element methods. January 1977-February 1990 (A Bibliography from the INSPEC: Information Services for the Physics and Engineering Communities data base). Report for January 1977-February 1990.** National Technical Information Service, Springfield, VA (USA). May 1990. 83p. Available from NTISPC N01/MF N01.

Supersedes PB-89-861488.

This bibliography contains citations concerning the use of finite element analysis in predicting groundwater flow through fractured or porous media. Topics include studies of contaminant transport, convection and dispersion, and heat transfer in groundwater systems. Studies in confined and unconfined aquifers are discussed. (This updated bibliography contains 142 citations, 15 of which are new entries to the previous edition.)

41656 (PB-90-869017/XAB) **Ground-water pollution transport: Model studies. January 1977-May 1990 (A Bibliography from the Selected Water Resources Abstracts data base). Report for January 1977-May 1990.** National Technical Information Service, Springfield, VA (USA). May 1990. 164p. Available from NTISPC N01/MF N01.

Supersedes PB-89-858831.

This bibliography contains citations concerning analytical and numerical simulations of the movement and distribution of contaminants in ground water. Pollutant transport and dispersion, two and three-dimensional modeling in homogeneous and heterogeneous materials, and site studies in specific hydrogeologic environments are among the topics discussed. Theoretical analyses and practical applications are included. (This updated bibliography contains 271 citations, 100 of which are new entries to the previous edition.)

41657 (PB-90-869124/XAB) **Groundwater: Volatile organic compounds (VOC's). March 1975-March 1990 (A Bibliography from the NTIS data base). Report for March 1975-March 1990.** National Technical Information Service, Springfield, VA (USA). May 1990. 82p. Available from NTISPC N01/MF N01.

Supersedes PB-90-850934.

This bibliography contains citations concerning volatile organic compounds (VOC's) in groundwater. The detection, identification, detection methods, and quantification of VOC's in groundwater, are covered. Methods for following the spread of the compounds and the removal of volatile organic compounds from groundwater are also included. Superfund decisions, environmental impact statements, and reports of the Installation Restoration Program undertaken by the military, as well as health assessment of water pollution by VOC's, are covered in separate bibliographies. (This updated bibliography contains 125 citations, 14 of which are new entries to the previous edition.)

41658 (PB-90-870411/XAB) **Acid precipitation: Effects on fresh-water ecosystems. April 1978-January 1990 (A Bibliography from the Life Sciences Collection data base). Report for April 1978-January 1990.** National Technical Information Service, Springfield, VA (USA). Jun 1990. 154p. Available from NTISPC N01/MF N01.

Supersedes PB-88-870233.

This bibliography contains citations concerning the effects of acidification on fresh water ecosystems. Algae and diatom distribution, survival and reproduction rates of specific fish species under acid lake conditions, and tolerance to stress caused by acidic conditions in fresh water ecosystems are studied. Effects of water pH on trace metal toxicity to fresh water organisms are briefly considered. Control and reduction of acidification are excluded from this bibliography. (This updated bibliography contains 331 citations, 41 of which are new entries to the previous edition.)

41659 (PB-90-871724/XAB) **Chemical analysis of trace elements for water pollution detection. August 1972-May 1990 (A Bibliography from the NTIS data base). Report for August 1972-May 1990.** National Technical Information Service, Springfield, VA (USA). Jun 1990. 85p. Available from NTISPC N01/MF N01.

This bibliography contains citations concerning the identification and analysis of trace elements and compounds occurring in water and water-related samples. The citations present methods of analysis and the equipment required for the determinations. Analytical techniques include spectrometry, inductively-coupled plasma, neutron activation, x-ray diffraction, fluorescence, and chromatography. A separate Published Search covers analysis of trace elements in air pollution detection. (Contains 134 citations fully indexed and including a title list.)

41660 (PB-90-871906/XAB) **Radioactive contamination and radionuclide migration in groundwater. April 1972-May 1990 (A**

Bibliography from the NTIS data base). Report for April 1972-May 1990. National Technical Information Service, Springfield, VA (USA). Jun 1990. 140p. Available from NTISPC N01/MF N01.

Supersedes PB-89-862247.

This bibliography contains citations concerning the contamination of groundwater with radionuclides and their subsequent migration. Monitoring surveys of existing sites with actual or potential radioactive groundwater contamination are included. Transport and migration models for radionuclides in groundwater are discussed. Natural radiation and accidental releases are considered in addition to anthropogenic sources of radioactive pollution such as waste storage and disposal. Contributions to radioactive pollution from uranium mining and processing is discussed in a separate bibliography. (This updated bibliography contains 235 citations, 26 of which are new entries to the previous edition.)

41661 (SAND-89-1368) **1988 environmental monitoring report, Sandia National Laboratories, Albuquerque, New Mexico.** Millard, G.; Yeager, G.; Phelan, J.; Wolff, T.; Pei, P.; Dionne, D.; Gray, C.; Thompson, D.; Hamilton, R. Sandia National Labs., Albuquerque, NM (USA). May 1989. 226p. Sponsored by U.S. DOE Environment Health & Safety. DOE Contract AC04-76DP00789. Order Number DE90013799. Available from NTIS, PC A11/MF A01 - OSTI; GPO Dep.

Sandia National Laboratories (SNL), Albuquerque is located south of Albuquerque on Kirtland Air Force Base. Because radionuclides are potentially released in small quantities from its research activities, SNL, Albuquerque has a continuing environmental monitoring program which analyzes for cesium-137, tritium, uranium, alpha emitters, and beta emitters in water, soil, air, and vegetation. A total of 5.23 curies of argon-41 were released as a result of SNL, Albuquerque operations in 1988. The albuquerque population received an estimated 0.04 person-rem from airborne radioactive releases, whereas it received greater than 44,500 person-rem from naturally occurring radionuclides. A nonradioactive effluent monitoring program at SNL, Albuquerque includes groundwater, stormwater and sewage monitoring. Results indicate that the groundwater has not been impacted by the chemical waste landfill. Preliminary testing of stormwater showed that no pollutants were above minimum detectable levels. A program to investigate potential remedial action sites has been started. 47 refs., 12 figs., 19 tabs.

41662 (UBA-FB-89-115) **Chlorinated hydrocarbons and toxic heavy metals in the Weser estuary.** Jathe, B.; Schirmer, M. Bremen Univ. (Germany, F.R.). Fachbereich 2 - Biologie/Chemie; Umweltbundesamt, Berlin (Germany, F.R.). Dec 1989. 165p. (In German). Contract UFOPLAN-Nr. 10204354. Available from Copy held by UB/TIB Hannover.

In the present study, data of the occurrence of heavy metals and selected organic compunds were compiled and analysed with respect to their spatial and temporal structure. The intention was to obtain an overview about the state of pollution within the Weser Estuary. The paper contains a presentation and description of the very heterogeneous data, connected with an assessment of the pollution situation of the Weser Estuary. The hydrographical, chemical and physical characteristics of the Weser Estuary are presented, as well as the concentrations of pollutants in the separate compartments water, suspended sediments, sediment and biota. The origin and loading of the substances are documented and their effects on organism are discussed. An estimation of the water quality in comparison to the rivers Elbe, Ems and Rhein closes the report. (orig.) With 117 refs., 46 tabs., 38 figs.

41663 (UCRL-JC-103587-Rev.1) **Nocturnal flow on a western Colorado slope: Revision 1.** Leone, J.M. Jr.; Gudiksen, P.H. Lawrence Livermore National Lab., CA (USA). Jun 1990. 9p. Sponsored by U.S. DOE Environment Health & Safety. DOE Contract W-7405-ENG-48. (CONF-900534-2-Rev.1: 18. NATO/CCMS international technical meeting on air pollution modelling and its applications, Vancouver (Canada), 13-17 May 1990). Order Number DE90013283. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The Department of Energy sponsored Atmospheric Studies in Complex Terrain (ASCOT) program has conducted a research program designed to increase our knowledge and understanding of terrain-dominated flows with specific emphasis on nocturnal flows within mountain valleys. ASCOT has sponsored both field studies and numerical modeling efforts to improve our understanding of the wind, temperature and turbulence structure of nocturnal drainage flows. One of the most recent ASCOT sponsored field studies involves a study within the Mesa Creek Basin in western Colorado to investigate the seasonal frequency of occurrence of drainage flows along the sloped surfaces and within the basin, and to evaluate the effect of the ambient meteorology on their development. The modeling portion of the study is being undertaken by Lawrence Livermore Laboratory using a three-dimensional prognostic boundary layer model to gain further insight into the dynamics of the seasonal variations and the effect of cloud cover on the development of the drainage flows. It is the purpose of this paper to present preliminary results from a numerical simulation done as part of this study. 4 refs., 7 figs.

41664 (WSRC-RP-89-161) **Pre-operational radio-environmental studies of Plant Vogtle.** Winn, W.G.; Sigg, R.A. Westinghouse Savannah River Co., Aiken, SC (USA). 1 May 1989. 63p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC09-89SR18035. Order Number DE90013627. Available from NTIS, PC A04/MF A01 - OSTI; GPO Dep.

This baseline study evaluates radioactivity in the environment near Plant Vogtle before initial reactor startup in 1987. These data will distinguish between any future radio-environmental effects from SRS and Plant Vogtle. Alpha, beta, and gamma-spectrometric methods analyzed river, stream, sediment, and soil samples. The study detected manmade radionuclides ^{3}H, ^{60}Co, ^{134}Cs, ^{137}Cs, ^{239}Pu, ^{240}Pu, and ^{241}Pu. However, all concentration levels are extremely low and are consistent with levels expected from fallout and from SRS operations in its early years. The measurements begun in this study continue to be used to monitor Vogtle post-startup effluents. 12 refs., 6 figs., 7 tabs.

41665 **Threats to the world's water.** la Riviere, J.W.M. *Scientific American (USA)*, 261(3): 80-94 (Sep 1989).

Water is in short supply in many regions; almost everywhere increasing amounts of organic waste and industrial pollutants threaten its quality. Only international cooperation in the integrated management of water resources can ameliorate the situation. Agriculture is usually the main drain on the water supply. Problems associated with overirrigation, increased population, and organic and industrial wastes are described. The paper explains the global water cycle; illustrates the uneven distribution of water among the oceans, ground water, ice caps, glaciers, lakes, and soil moisture; and gives data on the global water consumption from 1950 to 1980. Recommendations for water management are given.

41666 **Effects of acid stress on aerobic decomposition of algal and aquatic macrophyte detritus: Direct comparison in a radiocarbon assay.** Schoenberg, S.A. (Univ. of Georgia, Athens (USA)); Benner, R.; Armstrong, A.; Sobecky, P.; Hodson, R.E. *Applied and Environmental Microbiology (USA)*, 56(1): 237-244 (Jan 1990). DOE Contract AC09-76SR00819.

Radiolabeled phytoplankton and macrophyte lignocelluloses were incubated at pHs 4 and 7 in water from a naturally acidic freshwater wetland (Okefenokee Swamp; ambient pH, 3.8 to 4.2), a freshwater reservoir (L-Lake; pH 6.7 to 7.2), and a marine marsh (Sapelo Island; pH ~7.8). The data suggest that acidity is an important factor in explaining the lower decomposition rates of algae in Okefenokee Swamp water relative to L-Lake or Sapelo Island water. The decomposition of algal substrate was less sensitive to low pH (~5 to 35% inhibition) than was the decomposition of lignocellulose (~30 to 70% inhibition). These substrate-dependent differences were greater and more consistent in salt marsh than in L-lake incubations. In both freshwater sites, the extent to which decomposition was suppressed by acidity was greater for green algal substrate than for mixed diatom or blue-green algal (cyanobacteria) substrates. The use of different bases to adjust pH or incubation in a defined saltwater medium had no significant effect on substrate-dependent differences. Although pH differences with lignocellulose were larger in marine incubations, amendment of lake water with marine bacteria or with calcium, known to stabilize exoenzymes in soils, did not magnify the sensitivity of decomposition to acid stress.

55 BIOMEDICAL SCIENCES, BASIC STUDIES

5501 Behavioral Biology

Refer also to citation(s) 41617

5502 Biochemistry

Refer also to citation(s) 40503, 41151, 41246

41667 (DOE/ER/13461–5) **Active and passive calcium transport systems in plant cells: Progress report, May 1986–June 1990.** Sze, H. Maryland Univ., College Park, MD (USA). Dept. of Botany. [1990]. 5p. Sponsored by U.S. DOE Energy Research. DOE Contract FG05-86ER13461. Order Number DE90013954. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The ability to change cytoplasmic Ca^{2+} levels ($[Ca^{2+}]$) by cells has made this cation a key regulator of many biological processes. Cytoplasmic $[Ca^{2+}]$ is determined by the coordination of passive Ca^{2+} fluxes which increase cytosolic $[Ca^{2+}]$ and active Ca^{2+} transport systems that lower cytosolic $[Ca^{2+}]$. The mechanisms by which plant cells achieve this is poorly understood. We have initially used isolated vesicles from the plasma membrane or organellar membranes to study Ca^{2+} transport systems in oat roots (a monocot) and carrot suspension cells (a dicot). The objectives of the proposal were to identify and characterize active (energy-dependent) and passive calcium transport systems that work together to regulate calcium levels in the cytoplasm of plant cells. 10 figs., 2 tabs.

41668 (LBL–29028) **The production and repair of aflatoxin B_1-induced DNA damage.** Leadon, S.A. Lawrence Berkeley Lab., CA (USA). May 1990. 25p. Sponsored by U.S. DOE Energy Research; U.S. Department of Health and Human Services. DOE Contract AC03-76SF00098. Grant CA40453. (CONF-9005244–1: Mycotoxins, cancer and health conference, Baton Rouge, LA (USA), 17-18 May 1990). Order Number DE90013810. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

To investigate the influence of function or activity of a DNA sequence on its repair, we have studied excision repair of aflatoxin B_1 (AFB_1)-induced damage in the nontranscribed, heterochromatic alpha DNA of monkey cells and in the metallothionein genes of human cells. In confluent cells, AFB_1 adducts are produced in similar frequencies in alpha and in the rest of the DNA, but removal from alpha DNA is severely deficient, however, removal of AFB_1 adducts from alpha DNA is enhanced by small doses of UV. The repair deficiencies are not observed in actively growing cells. We have also shown that there is preferential repair of AFB_1 damage in active genes. AFB_1 damage is efficiently repaired in the active human metallothionein (hMT) genes, but deficiently repaired in inactive hMT genes. 51 refs., 3 tabs.

41669 (LBL–29070) **Computer modeling 16S ribosomal RNA.** Hubbard, J.M. Lawrence Berkeley Lab., CA (USA). Apr 1990. 250p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00098. Order Number DE90014183. Available from NTIS, PC A12/MF A01 - OSTI; GPO Dep.

It was the goal of this research to develop and implement a rational modeling protocol which could be applied to the folding of 16S ribosomal RNA. Modeling of a DNA dodecamer and comparison with the structures of the molecule obtained by NMR and x-ray crystallography reaffirm that the results obtained by modeling are dependent on the input data set. Transfer RNA modeling is used to demonstrate the feasibility of the new protocol and to explore what levels of structural shorthand can be successfully applied. Initially, a representation is employed which replaces each all-atom nucleotide with six pseudoatoms. With an alternate replacement scheme which emphasizes the helical substructures, it is possible to reduce the size of the model to be manipulated by more than twenty-fold and still obtain good results. The modeled structures clearly occupy the same area of conformational space as that of the tRNAs which have been determined by x-ray crystallography. The 16S ribosomal RNA at the heart of the small subunit of the ribosome has been extensively studied by physical, chemical, and phylogenetic means. Once the problems produced by the size of this molecule have been addressed, applying the new computer modeling protocol is straightforward. A closely related set of conformers is consistently obtained and these structures are comparable to models which include data from outside the computer parameter set. 108 refs., 74 figs.

41670 (PB–90-213737/XAB) **DNAdraw for formatting and drawing DNA sequences (documentation).** Shapiro, M. National Insts. of Health, Bethesda, MD (USA). Div. of Computer Research and Technology. 6 Apr 1990. 30p. Available from NTIS, PC A03/MF A01.

For system on diskette, see PB–90-502238.

DNAdraw is an IBM-PC program used to prepare publication-quality output of DNA sequences. The program is menu driven, with extensive help information. DNAdraw formats raw sequence data with counts and translation as specified, then allows editing and highlighting, with output to the LaserJet printer. Highlight options include bold, greek, italic, and reversed font text, boxes with 14 different shade patterns, underlines, sub and superscripts, and proportionally-spaced characters.

41671 (PB–90-502238/XAB) **DNAdraw (for microcomputers). Software.** Shapiro, M. National Insts. of Health, Bethesda, MD (USA). Div. of Computer Research and Technology. 13 Apr 1990. vp. Available from NTISCP D01.

The software is contained on 5 1/4-inch diskettes, high density (1.2M), compatible with the IBM PC microcomputer. The diskettes are in the ASCII format. Price includes documentation, PB–90-213737.

DNAdraw is an IBM-PC program used to prepare publication-quality output of DNA sequences. The program is menu driven, with extensive help information. DNAdraws formats raw sequence data with counts and translation as specified, then allows editing and highlighting, with output to the LaserJet printer. Highlight options include bold, greek, italic, and reversed font text, boxes with 14 different shade patterns, underlines, sub and superscripts, and proportionally-spaced characters. ...Software Description: The software is written in the C programming language for implementation on an IBM PC computer using the MS DOS 3.3 operating system. Additional requirements in hardware are: HP LaserJet II and PC graphics card.

41672 (PB–90-870874/XAB) **Genetic engineering of plants for improved crop production. December 1985-April 1990 (A Bibliography from the Biobusiness data base). Report for December 1985-April 1990.** National Technical Information Service, Springfield, VA (USA). Jun 1990. 105p. Available from NTISPC N01/MF N01.

Supersedes PB–89-861819.

This bibliography contains citations concerning the use of genetic engineering to improve crop production. Genetic alterations of plants that provide insect protection, herbicide resistance, disease resistance, improved quality, and higher yield are discussed. Methods of developing environmentally tolerant crops that are able to withstand extremes of temperature, reduced water consumption, and reduced fertilizer requirements are examined. Genetic engineering of microorganisms that are beneficial to plants is discussed in a separate bibliography. (This updated bibliography contains 213 citations, 70 of which are new entries to the previous edition.)

41673 Chorismic acid, a key metabolite in modification of tRNA. Hagervall, T.G. (Umea Univ., Umea (Sweden)); Joensson, Y.H.; Bjoerk, G.R.; Edmonds, C.G.; McCloskey, J.A. *Journal of Bacteriology (USA)*, 172(1): 252-259 (Jan 1990).

Chorismic acid is the common precursor for the biosynthesis of the three aromatic amino acids as well as for four vitamins. Mutants of Escherichia coli defective in any of the genes involved in the synthesis of chorismic acid are also unable to synthesize uridine 5-oxyacetic acid (cmo^5U) and its methyl ester ($mcmo^5U$). Both modified nucleosides are normally present in the wobble position of some tRNA species. Mutants defective in any of the specific pathways leading to phenylalanine, tyrosine, tryptophan, folate, enterochelin, ubiquinone, and menaquinone have normal levels of cmo^5U and $mcmo^5U$ in their tRNA. The presence of shikimic acid in the growth medium restores the ability of an aroD mutant to synthesize cmo^5U, while O-succinylbenzoate, which is an early

intermediate in the synthesis of menaquinone, does not. This, chorismic acid is a key metabolite in the synthesis of these tow modified nucleosides in tRNA. The absence of chorismic acid blocks the formation of cmo^5U and $mcmo^5U$ at the first step, which might be the formation of 5-hydroxyuridine. This results in an unmodified U in the wobble position of $tRNA_1^{Val}$ and in most of the tRNAs normally containing cmo^5U and $mcmo^5U$. Since cmo^5U and $mcmo^5U$ are synthesized under anaerobic conditions, the formation of these nucleosides does not require molecular oxygen. One of the carbon atoms of the side chain, $O\text{-}CH_2\text{-}COOH$, originates from the methyl group of methionine. The other carbon atom does not originate directly from the C-1 pool, from the carboxyl group of methionine, or from bicarbonate.

41674 Expression of Rhizobium leguminosarum CFN42 genes for lipopolysaccharide in strains derived from different R. leguminosarum soil isolates. Brink, B.A. (Marquette Univ., Milwaukee, WI (USA)); Noel, K.D.; Miller, J.; Carlson, R.W. *Journal of Bacteriology (USA),* 172(2): 548-555 (Feb 1990). DOE Contract FG09-87ER13810.

Two mutant derivatives of Rhizobium leguminosarum ANU843 defective in lipopolysaccharide (LPS) were isolated. The LPSs of both mutants lacked O antigen and some sugar residues of the LPS core oligosaccharides. Genetic regions previously cloned from another Rhizobium leguminosarum wild-type isolate, strain CFN42, were used to complement these mutants. One mutant was complemented to give LPS that was apparently identical to the LPS of strain ANU843 in antigenicity, electrophoretic mobility, and sugar composition. The other mutant was complemented by a second CFN42lps genetic region. In this case the resulting LPS contained O-antigen sugars characteristic of donor strain CFN42 and reacted weakly with antiserum against CFN42 cells, but did not react detectably with antiserum against ANU843 cells. Therefore, one of the CFN42 lps genetic regions specifies a function that is conserved between the two R. leguminosarum wild-type isolates, whereas the other region, at least in part, specifies a strain-specific LPS structure. Transfer of these two genetic regions into wild-type strains derived from R. leguminosarum ANU843 and 128C53 gave results consistent with this conclusion. The mutants derived from strain ANU843 elicited incompletely developed clover nodules that exhibited low bacterial populations and very low nitrogenase activity. Both mutants elicited normally developed, nitrogen-fixing clover nodules when they carried CFN42 lps DNA that permitted synthesis of O-antigen-containing LPS, regardless of whether the O antigen was the one originally made by strain ANU843.

41675 Purification and properties of an acetoacetyl coenzyme A-reacting phosphotransbutyrylase from Clostridium beijerinckii (Clostridium butylicum) NRRL B593. Thompson, D.K. (Virginia Polytechnic Institute and State Univ., Blacksburg (USA)); Chen, J.S. *Applied and Environmental Microbiology (USA),* 56(3): 607-613 (Mar 1990). DOE Contract FG05-85ER13368.

During the study of acetoacetyl coenzyme A (CoA)-reacting enzymes of Clostridium beijerinckii NRRL B593, a phosphate-dependent acetoacetyl-CoA-utilizing activity was detected in protein fractions devoid of thiolase and phosphotransacetylase. Further purification of this acetoacetyl-CoA-utilizing activity yielded an enzyme which may be designated as phosphotransbutyrylase (PTB; phosphate butyryltransferase [EC 2.3.1.19]). PTB from C. beijerinckii NRRL B593 was purified 160-fold with a yield of 14% and, with the best fractions, purified 190-fold to near homogeneity. It showed a native M_r of 205,000 and a subunit M_r of 33,000. PTB activity was sensitive to pH changes within the physiological range of 6 to 8. PTB exhibited a broad substrate specificity. The K_m values at pH 7.5 for butyryl-CoA, acetoacetyl-CoA, and acetyl-CoA were 0.04, 1.10, and 3.33 mM, respectively. The V_{max} values with butyryl-CoA and acetoacetyl-CoA were comparable, but the V_{max}/K_m was higher for butyryl-CoA than for acetoacetyl-CoA. An apparent K_m of 6.5 mM for phosphate was obtained with butyryl-CoA as the cosubstrate, whereas it was 12.9 mM with acetoacetyl-CoA as the cosubstrate. It remains to be established whether the putative compound acetoacetyl phosphate is produced in the PTB-catalyzed reaction with acetoacetyl-CoA.

41676 Electron trapping in double-stranded DNA: Implications for formation of double-stranded breaks. Rackovsky, S. (Univ. of Rochester School of Medicine and Dentistry, NY (USA)); Bernhard, W.A. *Journal of Physical Chemistry (USA),* 93(12): 5006-5008 (15 Jun 1989).

Calculations on electron trapping in DNA show that, in the absence of interstrand transfer, the hole on one strand will increase the probability of electron trapping on the other strand at the base directly opposite the hole. The roughly 20-fold increase results from the site acting as a sink for electrons initially localized about five bases to either side of it. In the absence of recombination, the resultant radical pair is positioned to potentiate a flush double-strand break.

5503 Cytology

41677 Cell volume increase in Escherichia coli after shifts to richer media. Kubitschek, H.F. (Argonne National Laboratory, IL (USA)). *Journal of Bacteriology (USA),* 172(1): 94-101 (Jan 1990). DOE Contract W-31-109-ENG-38.

Synchronous cultures of Escherichia coli 15-THU and WP2s, which were selected by velocity sedimentation from exponential-phase cultures growing in an acetate-minimal salts medium, were shifted to richer media at various times during the cell cycle by the addition of glucose or nutrient broth. Cell numbers and mean cell volumes were measured electronically. The duration of the division cycle of the shifted generation was not altered significantly by the addition of either nutrient. Growth rates, measured as rates of cell volume increase, were constant throughout the cycle in unshifted acetate control cultures. When glucose was added, growth rates also remained unchanged during the remainder of the cell cycle and then increased abruptly at or after cell division. When nutrient broth was added, growth rates remained unchanged from periods of 0.2 to 0.4 generations and then increased abruptly to their final values. In all cases, the cell volume increase was linear both before and after the growth rate transition. The strongest support for a linear cell volume increase during the cell cycle of E. coli in slowly growing acetate cultures, however, was obtained in unshifted cultures, in complete agreement with earlier observations of cell volumes at much more rapid growth rates. Although cell growth and division are under the control of the synthesizing machinery in the cell responsible for RNA and protein synthesis, the results indicate that growth is also regulated by membrane-associated transport systems.

5504 Genetics

Refer also to citation(s) 41668

41678 Genetic map of the Bacillus stearothermophilus NUB36 chromosome. Vallier, H. (Northwestern Univ., Evanston, IL (USA)); Welker, N.E. *Journal of Bacteriology (USA),* 172(2): 793-801 (Feb 1990).

A circular genetic map of Bacillus stearothermophilus NUB36 was constructed by transduction with bacteriophage TP-42C and protoplast fusion. Sixty-four genes were tentatively assigned a cognate Bacillus subtilis gene based on growth response to intermediates or end products of metabolism, cross-feeding, accumulation of intermediates, or their relative order in a linkage group. Although the relative position of many genes on the Bacillus subtilis genetic map appears to be similar, some differences were detected. The tentative order of the genes in the Bacillus stearothermophilus aro region is aspB-aroBAFEC-tyra-hisH-(trp), whereas it is aspB-aroE-tyrA-hisH-(trp)-aroHBF in Bacillus subtilis. The aroA, aroC, and aroG genes in Bacillus subtilis are located in another region. The tentative order of genes in the trp operon of Bacillus stearothermophilus is trpFCDABE, whereas it is trpABFCDE in Bacillus subtilis.

5505 Metabolism

Refer also to citation(s) 41679

5506 Medicine

Refer also to citation(s) 41046, 41460

41679 (ORNL/TM–11550) **Nuclear Medicine Program progress report for quarter ending March 31, 1990.** Knapp, F.F. Jr.; Ambrose, K.R.; Callahan, A.P.; Alfred, J.F.; Hasan, A.; Lambert, C.R.; McPherson, D.W.; Mirzadeh, S.; Srivastava, P.C.; Lambert, S.J. Oak Ridge National Lab., TN (USA). Jul 1990. 11p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE90013608. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The evaluation of the effects of albumin and albumin plus sodium palmitate in the phosphate buffer perfusate on the relative incorporation of 15-(p-[I-125]iodophenyl)-3-(R,S)-methylpentadecanoic acid (BMIPP) into endogenous lipids of isolated rat hearts has been studied. The effects of eluant salt character and concentration on the elution of [Re-188]perrhenate from the alumina-based tungsten-188/rhenium-188 generator system have also been investigated. During this period several agents were supplied to Medical Cooperative investigators, including [I-123]-labeled and [I-131]-labeled fatty acid analogues for studies at the Brookhaven National Laboratory and the Cardiology Department at the Free University of Amsterdam. Tungsten-188/rhenium-188 generators were supplied to the University of Massachusetts and the Center for Molecular Medicine and Immunology, in Newark, New Jersey. Osmium-191 was supplied for fabrication of generators for patient studies in Finland. 1 ref., 2 figs., 2 tabs.

41680 (PB–90-870130/XAB) **Nuclear magnetic resonance imaging. March 1982-April 1990 (A Bibliography from the US Patent data base). Report for March 1982-April 1990.** National Technical Information Service, Springfield, VA (USA). May 1990. 192p. Available from NTISPC N01/MF N01.

Supersedes PB–87-867909.

This bibliography contains citations of selected patents concerning imaging systems and system components in nuclear magnetic resonance methods and devices. Data acquisition methods, and applications in fluid flow analyses are presented. Some attention is given to magnet systems used in the imaging process. (This updated bibliography contains 364 citations, 220 of which are new entries to the previous edition.)

41681 (PB–90-870601/XAB) **Nuclear magnetic resonance: Applications in medical diagnosis. July 1986-September 1987 (A Bibliography from the INSPEC: Information Services for the Physics and Engineering Communities data base). Report for July 1986-September 1987.** National Technical Information Service, Springfield, VA (USA). Jun 1990. 47p. Available from NTISPC N01/MF N01.

See also PB–90-870619.

This bibliography contains citations concerning the applications of nuclear magnetic resonance (NMR) in medical diagnostic imaging. Whole body, tissue, and organ system imaging are discussed. New and improved equipment designs for special coils, distortion correction, artifact reduction, noise elimination, and image capturing and display are reviewed. A variety of methodologies are examined including spin-echo, proton chemical shift, ultra low field, and flip and flash imaging. Safety considerations are briefly mentioned. (This updated bibliography contains 85 citations, none of which are new entries to the previous edition.)

41682 (PB–90-870619/XAB) **Nuclear magnetic resonance: Applications in medical diagnosis. October 1987-April 1990 (A Bibliography from the INSPEC: Information Services for the Physics and Engineering Communities data base). Report for October 1987-April 1990.** National Technical Information Service, Springfield, VA (USA). Jun 1990. 158p. Available from NTISPC N01/MF N01.

Supersedes PB–87-866695. See also PB–90-870601.

This bibliography contains citations concerning the applications of nuclear magnetic resonance (NMR) in medical diagnostic imaging. Whole body, tissue, and organ system imaging are discussed. New and improved equipment designs for special coils, distortion correction, artifact reduction, noise elimination, and image capturing and display are reviewed. A variety of methodologies are examined including spin-echo, proton chemical shift, ultra low field, and flip and flash imaging. Safety considerations are briefly mentioned. (This updated bibliography contains 278 citations, all of which are new entries to the previous edition.)

41683 **Effects of chronic cocaine abuse on postsynaptic dopamine receptors.** Volkow, N.D. (Brookhaven National Laboratory, Upton, NY (USA)); Fowler, J.S.; Wolf, A.P.; Schlyer, D.; Shiue, C.Y.; Alpert, R.; Dewey, S.L.; Logan, J.; Bendriem, B.; Christman, D. *American Journal of Psychiatry (USA),* 147(6): 719-724 (Jun 1990).

To assess the effects of chronic cocaine intoxication on dopamine receptors in human subjects, the authors evaluated [^{18}F]N-methylspiroperidol binding using positron emission tomography in 10 cocaine abusers and 10 normal control subjects. Cocaine abusers who had been detoxified for 1 week or less showed significantly lower values for uptake of [^{18}F]N-methylspiroperidol in striatum than the normal subjects, whereas the cocaine abusers who had been detoxified for 1 month showed values comparable to those obtained from normal subjects. The authors conclude that postsynaptic dopamine receptor availability decreases with chronic cocaine abuse but may recover after a drug-free interval.

5507 Microbiology

Refer also to citation(s) 40284, 40323, 40359, 41046, 41122

5510 Physiological Systems

41684 (CRIE-U–89023) **Continuous measurement of electrical characteristics in plants. 3.: Application to hydroponic solution pH control.** Sekiyama, T.; Haniyu, H.; Saiki, H. Central Research Inst. of Electric Power Industry, Abiko, Chiba (Japan). Sep 1989. 22p. (In Japanese). Order Number DE90507853. Available from NTIS (US Sales Only), PC A03/MF A01.

Controlling pH of nutrient solution and keeping the other conditions unchanged, measurements of variation in electric potential difference between leaf and hypocotyl of a bush bean plant was performed for about seven days. Silver electrodes 0.3mm in diameter were glued on the surface of the plant using conductive paste prepared by dissolving gelatine in Ringel ' s solution. The results obtained are summarized as follws: first, when pH of the solution is suddenly increased or decreased, the potential of leave becomes high or low with respect to that of hypocotyl respectively; second, the variation in potential difference between them is affected by the rate at which pH of the solution is adjusted, although the total variation of pH is controlled to be the same, and in particular by mild adjustment (0.02 - 0.05pH/min) it is reduced to 1/2 - 1/4 of that produced by sudden change; third, abrupt change in pH of the solution cause to the plant the temporary suppression of its water absorption having a duration of 7 - 15 minutes. A short account is given of a non-contact type measurement of bioelectric potential performanced by making use of a Faraday ' s cage. 11 refs., 12 figs.

5530 Agriculture and Food Technology

Refer also to citation(s) 40785

41685 (IAEA-TECDOC–545) **Asian regional co-operative project on food irradiation: Research and development: Report of a co-ordinated research programme.** International Atomic Energy Agency, Vienna (Austria); Food and Agriculture Organization of the United Nations, Rome (Italy). Mar 1990. 185p. Order Number DE90633837. Available from NTIS (US Sales Only), PC A09/MF A01; OSTI; INIS.

The importance of food irradiation to reduce post-harvest food losses, improve the hygienic quality of foods and facilitate trade promotion has been recognized by the region of Asia and the Pacific. Several of the regional countries have initiated national programmes on food irradiation in the 50s and 60s. The first coordination programme sponsored by the Agency under RCA in 1974-1979 was the Coordinated Research Programme (CRP) on Radiation Preservation of Fish and Fishery Products. The Asian Regional Cooperative Project on Food Irradiation (RPFI) was implemented by the Agency in 1980 under the sponsorship of the Government of Japan. Bangladesh, People's Republic of China, India, Indonesia, Republic of Korea, Japan, Pakistan, the Philippines, Sri Lanka, Thailand and Vietnam participated in this Programme. Under the scope of this regional project R and D work was carried

out on: (i) insect disinfestation and improving hygienic quality of dried and cured fishery products, (ii) insect disinfestation and shelf-life extension of mangoes; (iii) control of sprouting of onions, and (iv) improving hygienic quality of spices. In addition some work related to economic feasibility of food irradiation was also carried out. This publication contains the results of R and D conducted under the RPFI. Under the RPFI, it was demonstrated that the food irradiation technology could play an important role in reducing food losses and facilitating wider distribution of certain food products. The RPFI provided a strong impetus for Asian countries to coordinate their research programmes effectively towards the practical application of the technology to combat food losses and to make more food available to the population in the region. Refs, figs and tabs.

41686 (IAEA-TECDOC–545, pp. 13-18) **Storage properties of Japanese onions irradiated on a large scale.** Kawashima, K. (National Food Research Inst., Tsukuba, Ibaraki (Japan)); Hayashi, T.; Umeda, K. International Atomic Energy Agency, Vienna (Austria); Food and Agriculture Organization of the United Nations, Rome (Italy). Mar 1990. In *Asian regional co-operative project on food irradiation: Research and development: Report of a co-ordinated research programme.* Order Number DE90633837. Available from NTIS (US Sales Only), PC A09/MF A01; OSTI; INIS.

One ton each of dried onions of var. Kitamki and var. Ohotsuku were obtained. Half of each variety was irradiated with doses of 38.1 to 65.2 Gy. Both irradiated and unirradiated onions were stored either at 0 or 5 deg. C from September 1982 to spring 1983. Cold storage inhibited sprouting of unirradiated onions, but not the development of green inner buds. Sprouting and green inner bud development were accelerated by room temperature storage. Browning of small inner buds in irradiated onions held in cold storage was insignificant; room temperature storage increased browning. Only onions that were irradiated and stored at a low temperature had satisfactory commercial quality in March and April. (author). 6 figs.

41687 (IAEA-TECDOC–545, pp. 19-52) **Integrated studies on irradiated Philippine mangoes.** Manalo, J.A. (Philippine Women's Univ., Manila (Philippines). Div. of Science and Technology); Legaspi, E.; Quarteros, R.; Grimares, L.; Escano, L.; Marzan, A.; Lanuza, A.; Singson, C.C. International Atomic Energy Agency, Vienna (Austria); Food and Agriculture Organization of the United Nations, Rome (Italy). Mar 1990. In *Asian regional co-operative project on food irradiation: Research and development: Report of a co-ordinated research programme.* Order Number DE90633837. Available from NTIS (US Sales Only), PC A09/MF A01; OSTI; INIS.

The presence of the fruitfly, Dacus dorsalis Hendel, has restricted export of Philippine mangoes to Japan and other countries with strict quarantine requirements. The anticipated banning of the ethylene dibromide (EDB) as fumigant necessitated studies to find a suitable replacement. Based on the encouraging results of previous disinfestation experiments further studies utilizing irradiation and its combination with a hot water dip were undertaken. The objective of the studies was to interrelate the effects of the disinfestation method to fruit maturity, storage temperature, and some related processes, including shipping, on the shelf-life, chemical, and sensory attributes of the carabao mango. Results show that the combination treatment of 0.65 kGy and a hot water dip at 50 deg. C for 5 minutes can be a good alternative for ethylene dibromide with the added benefit of shelf life extension. The chemical, nutritive and sensory characteristics of the fruit also are retained. 32 refs, 19 tabs.

41688 (IAEA-TECDOC–545, pp. 53-68) **Quality changes of irradiated spices stored in different indigenous packaging materials.** Saputra, T.S. (National Atomic Energy Agency, Jakarta (Indonesia). Centre for the Application of Isotopes and Radiation); Maha, M.; Purwanto, Z.I. International Atomic Energy Agency, Vienna (Austria); Food and Agriculture Organization of the United Nations, Rome (Italy). Mar 1990. Contract IAEA-R-2630/RI/JN. In *Asian regional co-operative project on food irradiation: Research and development: Report of a co-ordinated research programme.* Order Number DE90633837. Available from NTIS (US Sales Only), PC A09/MF A01; OSTI; INIS.

The changes in quality of irradiated spices, i.e., nutmeg (Myristica fragrans), black pepper and white pepper (Piper nigrum) stored in different indigenous packaging materials were evaluated. Packaging materials used were tin cans; tin can lined with polypropylene film, tin can lined with wrapping paper, woven polypropylene bag and woven polypropylene bag lined with polypropylene film. Packaging in woven polypropylene bag could cause significant changes in a_w-values and moisture contents of the spices. In the tin can, no significant change was found during storage. By applying a polypropylene film liner inside the plastic bag, the changes could be retarded. The other parameters observed, i.e. total plate count, total mould and yeast count and organoleptic scores of the samples were not significantly affected by the packaging method. A dose of 5 kGy could reduce the microbial load of the spices by about 2-3 log cycles. A significant decrease in a_w-value and moisture content of nutmeg, and organoleptic scores of pepper was also found due to irradiation. Prolonged storage caused a significant decrease in organoleptic properties of the spices. After prolonged storage, the microbial load of nutmeg and black pepper showed a significant decrease, while in white pepper a slight increase was observed. (author). 15 refs, 3 tabs.

41689 (IAEA-TECDOC–545, pp. 69-91) **Trial intercountry shipment of irradiated spices.** Saputra, T.S. (National Atomic Energy Agency, Jakarta (Indonesia). Centre for the Application of Isotopes and Radiation); Maha, M.; Purwanto, Z.I.; Farkas, J. International Atomic Energy Agency, Vienna (Austria); Food and Agriculture Organization of the United Nations, Rome (Italy). Mar 1990. In *Asian regional co-operative project on food irradiation: Research and development: Report of a co-ordinated research programme.* Order Number DE90633837. Available from NTIS (US Sales Only), PC A09/MF A01; OSTI; INIS.

The quality of irradiated whole nutmeg (Myristica fragrans) and whole white pepper (Piper nigrum) packaged in locally available material was evaluated. The spice samples were packaged in tin-containers or woven polypropylene (PP) bags, with or without oxygen absorber in the package, irradiated at 5 kGy, and shipped from Jakarta to Wageningen by sea-freight. The shipment was made in small and in commercial-size packages. Irradiation effectively disinfested and decontaminated spices without altering their chemical composition and sensory properties. (PP) bags, particularly those without an inner liner, did not withstand rough handling and did not prevent reinfestation during shipment. Tin containers did withstand rough handling and prevented re-infestation. The oxygen absorber had no effect on microbial count and the other parameters of the spices. (author). 22 refs, 12 tabs.

41690 (IAEA-TECDOC–545, pp. 93-116) **Pilot-scale studies of dried fish irradiation: Bulk packaging of irradiated dried fish.** Maha, M. (National Atomic Energy Agency, Jakarta (Indonesia). Centre for the Application of Isotopes and Radiation); Irawati, Z.; Nasram, S.; Kicky, L.T.K. International Atomic Energy Agency, Vienna (Austria); Food and Agriculture Organization of the United Nations, Rome (Italy). Mar 1990. In *Asian regional co-operative project on food irradiation: Research and development: Report of a co-ordinated research programme.* Order Number DE90633837. Available from NTIS (US Sales Only), PC A09/MF A01; OSTI; INIS.

Two methods of salting fresh chub mackerel (R. neglectus) were examined: dry salting and brine salting. With dry salting (and sun drying) moulding occurs after 1 month. Sorbate prevents moulding. Irradiation reduces the bacterial population. Best results are obtained with sorbate and radiation used in combination. The brine salting investigation was not completed at the time of writing. Packaging materials for study were selected on the basis of the physical protection that could be obtained and also cost. Based on drop tests, irradiation of polyethylene film with doses up to 10 kGy does not significantly affect tensile strength or tear resistance. Similar results were obtained with polypropylene woven cloth. Carton boxes were unchanged with doses up to 5 kGy. Carton boxes are more suitable than woven bags for large scale irradiation. (author). 2 figs, 12 tabs.

41691 (IAEA-TECDOC–545, pp. 117-125) **Transportation and consumer acceptance studies of irradiated dried fish.** Maha, M. (National Atomic Energy Agency, Jakarta (Indonesia). Centre for the Application of Isotopes and Radiation); Puwanto, Z.I.; Nasran,

S. International Atomic Energy Agency, Vienna (Austria); Food and Agriculture Organization of the United Nations, Rome (Italy). Mar 1990. Contract IAEA-R-2506/R1/RB. In *Asian regional co-operative project on food irradiation: Research and development: Report of a co-ordinated research programme.* Order Number DE90633837. Available from NTIS (US Sales Only), PC A09/MF A01; OSTI; INIS.

To evaluate the feasibility of dried fish irradiation, transportation studies of irradiated dried fish, either by land or by sea under practical conditions, have been carried out. A small-scale consumer acceptance test was also done to support the possible commercial application of the irradiation process. Dried salted chub mackerel (Rastrelliger neglectus) packaged in polyethylene pouches and then packed in master cartons of up to 20 kg capacities were transported by truck from Jakarta to Bandung, and from Jakarta to Ujung Pandang by cargo boat after being irradiated at 0.5 kGy. Unirradiated samples were also included in the trials in order to compare the results. It was found that carton boxes of 20 kg capacity provided with strapping bands are durable for transportation of dried fish. A dose of 0.5 kGy was sufficient to prevent insect damage and also reduced the incidence of mould growth on dried fish. However, chemical deterioration, such as oxidative rancidity and brown discolouration could not be prevented by irradiation. In general, organoleptic properties of unirradiated and irradiated dried fish showed no significant difference. Irradiated dried fish could be marketed for about 3-4 months at ambient conditions. (author). 3 tabs.

41692 (IAEA-TECDOC–545, pp. 127-147) **Shelf life extension of dried shrimps by irradiation.** Vibulsresth, P. (Kasetsart Univ., Bangkok (Thailand)); Haruthaithanasan, B.; Vananuvat, N.; Bhumibhamon, O.; Boon Long, N.; Chakpaiwong, W. International Atomic Energy Agency, Vienna (Austria); Food and Agriculture Organization of the United Nations, Rome (Italy). Mar 1990. In *Asian regional co-operative project on food irradiation: Research and development: Report of a co-ordinated research programme.* Order Number DE90633837. Available from NTIS (US Sales Only), PC A09/MF A01; OSTI; INIS.

By reducing the number of bacteria, irradiation with a dose of 3 kGy increased the shelf life of dried and salted shrimp. Combining radiation with low-temperature storage further increased shelf life. Vacuum packaging the shrimp in polyethylene-laminated polyethylene bags resulted in extension of the shelf life by more than 15 weeks. Packing in tupperware and polyethylene bags was less effective. Most of the bacteria in the dried and salted shrimps were halophiles. Salmonellae and coliforms were not detected in the samples studied. During storage, ammonia was formed in the shrimps. Irradiation caused less ammonia to be formed. Low-temperature storage also reduced ammonia formation. The sensory quality of the shrimps decreased with increasing amounts of ammonia. (author). 9 refs, 25 figs.

41693 (IAEA-TECDOC–545, pp. 149-164) **Time temperature tolerance and packaging studies of irradiated dried fish.** Ahmed, M. (Institute of Food and Radiation Biology, Dacca (Bangladesh)); Bhuiya, A.D.; Hossain, M.M.; Islam, M.A.; Joarder, G.K.; Majumder, T.K. International Atomic Energy Agency, Vienna (Austria); Food and Agriculture Organization of the United Nations, Rome (Italy). Mar 1990. In *Asian regional co-operative project on food irradiation: Research and development: Report of a co-ordinated research programme.* Order Number DE90633837. Available from NTIS (US Sales Only), PC A09/MF A01; OSTI; INIS.

The bacterial flora of sun-dried, Cybium guttatum (Mackerel) irradiated at 0.0, 0.50, 1.0, 2.0 or 4.0 kGy and stored at temperatures of 10, 20 or 28 deg. C, was investigated. The reduction of bacterial flora was determined both qualitative and quantitatively. In studies over three months' storage, the occurrence of both mesophiles and psychrophiles/psychrotolerants was determined. No over-all reduction of significance was achieved during this period. Only in case of mesophiles was an 80% reduction obtained. The psychrophiles/psychrotolerants were found to be less sensitive to these dose levels. Several hundred bacterial isolates (both mesophiles and psychrophiles) were made from the count-plates and identified. Micrococcus, Staphylococcus, Corynebacterium and some Bacillus were found to be the prominent groups in mesophiles while Bacillus dominated psychrophiles. Salmonella was not found either in control or irradiated samples. Only a few coliforms and moulds (less than 30/gm) were found. Yeast was absent in both control and irradiated samples. Tin containers, gunny bags lined with polythene and carton boxes were used as packaging materials. About half of the unirradiated dried fish spoiled due to fungus growth. Weight loss due to insects varied from 6-10%. Tin containers proved best as packaging material during two months of storage. (author). 14 refs, 1 fig., 7 tabs.

41694 (IAEA-TECDOC–545, pp. 165-181) **Economic feasibility of using gamma radiation for the preservation of some agricultural commodities in the Philippines.** Singson, C.C. (Philippine Atomic Energy Commission, Diliman, Quezon City (Philippines). Dept. of Nuclear Services). International Atomic Energy Agency, Vienna (Austria); Food and Agriculture Organization of the United Nations, Rome (Italy). Mar 1990. In *Asian regional co-operative project on food irradiation: Research and development: Report of a co-ordinated research programme.* Order Number DE90633837. Available from NTIS (US Sales Only), PC A09/MF A01; OSTI; INIS.

Onions irradiated with an average dose of 8.7 krad and stored under refrigeration for 5 months had 20 to 31% less loss than non-irradiated onions. Garlic irradiated with an average dose of 9.3 krad and stored under refrigeration for up to 7 months had 7.5% less loss at 5 months and 14.6% less loss at 7 months than non-irradiated garlic. Irradiation with 50 krad delayed yellowing of mangoes, but the effect varied with variety. The emergence of adult fruit flies was prevented by irradiation. Economic analyses of the irradiation of onions, garlic and mangoes indicated that irradiation can provide advantageous savings. (author). 2 refs, 12 tabs.

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Refer also to citation(s) 40461, 40669, 40783, 41116, 41534, 41621, 41744

41695 (AD-A–219960/2/XAB) **Utility of interleukin-1 in therapy of radiation injury as studied in small and large animal models.** Neta, R.; Monroy, R.; MacVittie, T.J. Naval Medical Research Inst., Bethesda, MD (USA). 1989. 12p. (NMRI–89-118). Available from NTIS, PC A03/MF A01.

Pub. in Biotherapy, Vol. 1, 301-311(1989).

Interleukin-1 (IL-1) has been recognized for some time as a mediator of fever, inflammation, and neutrophilia. More recently, IL-1 has been identified as a radioprotectant and as hematopoietic 1 (by its virtue to enhance growth of high proliferative macrophage CFC's). Furthermore, in vivo (in mice) and in vitro (in diverse cell types) IL-1 induces production of hematopoietic growth factors. All the above properties led to increased interest in the role of IL-1 as a mediator of constitutive and emergency hematopoiesis and the systematic inflammatory process. Consequently, for the past several years our laboratory has focused on analyzing the hematopoietic and inflammatory effects of recombinant human IL-1 in three preclinical animal models, the mouse, canine, and nonhuman primate. We hope that this review will aid in providing preclinical information on the role of IL-1 in hematopoiesis and inflammation and in this regard be useful in the design of clinical protocols.

41696 (AD-A–220145/7/XAB) **Study of emergency room health care providers and the fixed facility physical capabilities to manage the presenting radiologically injured patient. Study report, July 1984-July 1985.** Academy of Health Sciences (Army), Fort Sam Houston, TX (USA). Health Care Administration. Jul 1985. 90p. (HCA–147-88). Available from NTIS, PC A05/MF A01.

This study examined emergency room health care providers to determine if their knowledge and clinical expertise is sufficient to appropriately manage radiologically injured patient. This study posed an unannounced disaster preparedness drill to measure the ability of the emergency room staff to care for radiologically injured patients. This study produced a checklist for measurement of the care. The clinical expertise and performance were satisfactory. The

instrument for measuring the abilities of the clinical staff provided useful, but required some modification.

41697 (AD-A-220532/6/XAB) **Reduction of 3-methoxytyramine concentrations in the caudate nucleus of rats after exposure to high-energy iron particles: Evidence for deficits in dopaminergic neurons.** Hunt, W.A.; Dalton, T.K.; Joseph, J.A.; Rabin, B.M. Armed Forces Radiobiology Research Inst., Bethesda, MD (USA). 1990. 7p. (AFRRI-SR-90-2). Available from NTIS, PC A02/MF A01.

Pub. in Radiation Research, Vol. 121, 169-174(1990).

The prospect of long-term space travel raises a number of questions about the safety of astronauts asked to venture on prolonged journeys. The problems of microgravity are well known, but the hazards of exposure to radation are less understood. Most space travel has involved a few days to many months in low-altitude, equatorial orbits, where the dangers of radiation are lessened by the magnetic field surrounding the earth. Travel to polar or geostationary orbits or travel to the moon or the planets has a far greater radiation hazard. Almost nothing is known about possible risks to behavior and brain function after radiation exposure, such as found after the emission of solar flares or from long-term exposure from galactic cosmic radiation. Exposure to low doses of high-energy iron particles can alter motor behavior. The ability of rats to hang from a wire has been reported to be significantly degraded after exposure to doses as low as 0.5 Gy. In addition, deficits in the ability of acetylcholine to regulate dopamine release in the caudate nucleus (an area in the brain important for motor function) have been found. These results provide further evidence that exposure to heavy particles can degrade motor behavior through an action on dopaminergic mechanisms and that this can occur after doses much lower than those needed for low-LET radiation.

41698 (AD-A-220539/1/XAB) **Behavioral and neurochemical abnormalities after exposure to low doses of high-energy iron particles.** Hunt, W.A.; Joseph, J.A.; Rabin, B.M. Armed Forces Radiobiology Research Inst., Bethesda, MD (USA). 1989. 5p. (AFRRI-SR-90-3). Available from NTIS, PC A01/MF A01.

Pub. in Adv. Space Res., Vol. 9, No. 10, (10)333-(10)336(1989).

Exposure of rats to high-energy iron particles (600 MeV/amu) has been found to alter behavior after doses as low as 10 rads. The performance of a task that measures upper body strength was significantly degraded after irradiation. In addition, an impairment in the regulation of dopamine release in the caudate nucleus (a motor center in the brain), lasting at least 6 months, was also found and correlated with the performance deficits. A general indication of behavioral toxicity and an index of nausea and emesis, the conditioned taste aversion, was also evident. The sensitivity to iron particles was 10-600 times greater than to gamma photons. These results suggest that behavioral and neurobiological damage may be a consequence of exposure to low doses of heavy particles and that this possibility should be extensively studied.

41699 (BMU-1989-220) **Determination and evaluation of the radiation dose to the population due to incorporation of natural radioactivity.** Schriftenreihe Reaktorsicherheit und Strahlenschutz. Ergebnisberichte, Untersuchungen, Studien, Gutachten. Gloebel, B.; Berlich, J.; Keller, K.D.; Bauer, U.; Andres, C.; Zaeh, I.; Malter, G.; Fehrenz, K.; Lehnen, H.; Fehringer, F. Bundesministerium fuer Umwelt-, Naturschutz und Reaktorsicherheit, Bonn (Germany, F.R.); Universitaet des Saarlandes, Homburg/Saar (Germany, F.R.). Inst. fuer Radiologische Physik. Mar 1989. 234p. (In German). Contract BMU St.Sch. 727. Available from GRM Werbeberatung - Werbemittlung - PR, Eggenstein-Leopoldshafen, (Germany, F.R.).

Of all natural radioactivity the uranium-radium and thorium decay chain each contribute essentially to the internal radiation exposure of human populations. The objective of the investigations carried out during the past years was on the one hand to determine the contents of the radionuclides ^{3}H/uranium, radium, lead, polonium and thorium in the human body and furthermore to determine the relevant ingestion pathways as regards type and activity of the natural radioactive substances incorporated in foodstuffs and drinking water. For this purpose both human organ samples and environmental samples including foodstuffs and drinking water, essentially from the Saarland, but also from other regions of the FRG, were taken and analyzed. The methods used, as far as deviating from standard methods, are described. The measuring results are given and discussed. A concluding evaluation assigns the natural internal radiation exposure within the other risks of everyday life. The concentrations determined and the ingestion of the essential natural radionuclides are presented in tables. The radiation dose is estimated from the respective tissue concentration. (orig./HP).

41700 (DOE/ER/60502-4) **The development of in vitro mutagenicity testing systems using T-lymphocytes: Annual performance report, November 1, 1989-October 31, 1990.** Albertini, R.J. Vermont Univ., Burlington, VT (USA). Jun 1990. 16p. Sponsored by U.S. DOE Energy Research. DOE Contract FG02-87ER60502. Order Number DE90014432. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

We have continued our studies of the in vitro induction of mutations by gamma irradiation. We have also employed irradiation followed by incubation with cytosine-arabinoside (ara-C) to inhibit DNA repair and accumulate repairing regions to study the role of repair in this mutation induction. These studies have defined the procedures that allow the quantification of in vitro induction of mutations at the hprt gene. We have recently initiated study of the in vitro mutagenicity of Auger electrons and other low energy irradiations emitted by ^{201}Tl. We will compare the ^{201}Tl results to those of the beta emitter ^{204}Tl. These in vitro results will be compared with in vivo results in patients undergoing medical diagnostic procedures which employ ^{201}Tl. Briefly, cells were exposed to ^{201}Tl in vitro and the mutant frequency measured by the methods developed in the study of gamma irradiation. Also discussed are the molecular characterization of hprt mutations and the development of an HLA loss mutation assay. 4 figs., 5 tabs.

41701 (EUR-11464) **Radiation protection programme progress report 1987.** Commission of the European Communities, Luxembourg (Luxembourg). 1988. 1763p. (In DE, EN, FR). Available from NTIS (US Sales Only), PC A99/MF A01.

The progress report of the radiation protection programme outlines the research work carried out in the year 1987 under contracts between the Commission of the European Communities and research groups in the Member States. Results of more than 320 projects are reported. They are grouped into six sectors: radiation dosimetry and its interpretation, behaviour and control of radionuclides in the environment, non-stochastic effects of ionizing radiation, radiation carcinogenesis, genetic effects of ionizing radiation, evaluation of radiation risks and optimization of protection. Within the framework programme, the aim of this scientific research is to improve the conditions of life with respect to work and protection of man and his environment and to assure a safe production of energy, i.e.: (i) to improve methods necessary to protect workers and the population by updating the scientific basis for appropriate standards; (ii) to prevent and counteract harmful effects of radiation; (iii) to assess radiation risks and provide methods to cope with the consequences of radiation accidents.

41702 (GSF-2/90) **Calculation of organ doses from environmental gamma rays using human phantoms and Monte Carlo methods. Pt. 1. Monoenergetic sources and natural radionuclides in the ground.** Saito, K. (Japan Atomic Energy Research Inst., Tokai, Ibaraki (Japan). Dept. of Environmental Safety Research); Petoussi, N.; Zankl, M.; Veit, R.; Jacob, P.; Drexler, G. Gesellschaft fuer Strahlen- und Umweltforschung mbH Muenchen, Neuherberg (Germany, F.R.). Inst. fuer Strahlenschutz. Jan 1990. 99p. Contract BMU St.Sch. 1048. Order Number DE90510286. Available from NTIS (US Sales Only), PC A05/MF A01.

Organ doses from environmental γ-rays (U-238, Th-232, K-40) were calculated using Monte Carlo methods for three typical sources of a semi-infinite volume source in the air, an infinite plane source in the ground and a volume source in the ground. γ-ray fields in the natural environment were simulated rigourously without approximations or simplifications in the intermediate steps except for the disturbance of the radiation field by the human body which was neglected. Organ doses were calculated for four anthropomorphic phantoms representing a baby, a child, a female and a male adult. The dose of a fetus is given by the dose to the uterus of the adult female. Air kerma and dose conversion factors normalised to

air kerma and to source intensity are given for monoenergetic sources and for the natural radionuclides. (orig./HP).

41703 (JINR-E-19-89-239) **The shape of survival curves for pions and X-rays in a living tissue.** Lokajicek, M. (Ceskoslovenska Akademie Ved, Prague (Czechoslovakia). Fyzikalni Ustav). Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems. 1989. 11p. Order Number DE90633693. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Survival curves established in vitro may differ from those being responsible for cell inactivation in living tissues. They should be determined under corresponding conditions. A mathematical model is developed giving a possibility of determining the actual shapes of survival curves from macroscopic effects obtained with the help of different fractionation schemes under the conditions when the influence of proliferation processes can be neglected. The survival curves for pions (in peak) and X-rays derived from available experimntal fraction data exhibit rather complex characteristics. There is a second shoulder on the survival curves at highr doses. This is expressed strongly mainly for pions, which can be related to a very complex energy distribution after the absorption of negative pions by an atom nucleus. It cannot be neglected at higher doses for X rays, either. 7 refs.; 4 figs.

41704 (LA-UR-90-355) **Nuclear particles in cancer treatment: Brief review.** Raju, M.R. Los Alamos National Lab., NM (USA). [1990]. 16p. Sponsored by U.S. DOE Energy Research. DOE Contract W-7405-ENG-36. (CONF-900983-1: Workshop on physical techniques in medical sciences, Calcutta (India), Sep 1990). Order Number DE90006514. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

Declassified 18 December 1989.

This report consist of comments in response to specific topics pertaining to temperature and radionuclides as requested by the Hanford Operations Office, US Atomic Energy Commission. These comments include scientific opinion and engineering judgment in addition to factual information. The material has been grouped in a convenient manner because of the relationships between topics but the reader is cautioned that this does not constitute complete treatment of the subjects outlined. The literature has been cited, particularly the recent reports, but the bibliography is by no means exhaustive. This report is based on material provided by Radiological Engineering and Water Plant and Utilities Engineering personnel of Irradiation processing Department; Biology Operation and Radiation Protection Operation personnel of Hanford Laboratories Operation.

41705 (N-90-21715) **Simplified model for solar cosmic ray exposure in manned Earth orbital flights.** Wilson, J.W.; Khandelwal, G.S.; Shinn, J.L.; Nealy, J.E.; Townsend, L.W.; Cucinotta, F.A. National Aeronautics and Space Administration, Hampton, VA (USA). Langley Research Center. May 1990. 15p. (NASA-TM-4182;L-16738;NAS-1.15:4182). Available from NTIS, PC A03/MF A01.

A simple calculational model is derived for use in estimating solar cosmic ray exposure to critical body organs in low-Earth orbit at the center of a large spherical shield of fixed thickness. The effects of the Earth's geomagnetic field, including storm conditions and the astronauts' self-shielding, are evaluated explicitly. The magnetic storm model is keyed to the planetary index K(sub p).

41706 (PB-90-216011/XAB) **Neutrophil myeloperoxidase destruction by ultraviolet irradiation.** Hanker, J.; Giammara, B.; Strauss, G. North Carolina Univ., Chapel Hill, NC (USA). ©1988. 4p. Available from NTIS, PC A01/MF A01.

Pub. in Jnl. of Electron Microscopy, 138-139(Jun 1988).

The peroxidase activity of enriched leukocyte preparations on coverslips was determined cytochemically with a newly developed method. The techniques utilizes diaminobenzidine medium and cupric nitrate intensification and is suitable for analysis with light microscopy, SEM, and TEM. Blood specimens from control individuals were studied with and without in vitro UV irradiation and compared with those from psoriasis patients exposed therapeutically to various types of UV in phototherapy. All UV irradiated samples showed diminished neutrophil myeloperoxidase (MP) activity although that of the principal eosinophil peroxidase was unaffected. The SEMs supported the contention that decreased neutrophil MP activity might be related to UV induced degranulation. It is believed to be possible, eventually, to equate the observed MP degranulation effect after UV irradiation with diminished ability to fight bacterial infections.

41707 (PNL-6198-Rev.1) **Hanford whole body counting manual: Revision 1.** Palmer, H.E.; Rieksts, G.A.; Lynch, T.P. Pacific Northwest Lab., Richland, WA (USA). Jun 1990. 176p. Sponsored by U.S. DOE Environment Health & Safety. DOE Contract AC06-76RL01830. Order Number DE90014333. Available from NTIS, PC A09/MF A01; OSTI; INIS; GPO Dep.

This document describes the Hanford Whole Body Counting Program as it is administered by Pacific Northwest Laboratory (PNL) in support of the US Department of Energy-Richland Operations Office (DOE-RL) and its Hanford contractors. Program services include providing in vivo measurements of internally deposited radioactivity in Hanford employees (or visitors). Specific chapters of this manual deal with the following subjects: program operational charter, authority, administration, and practices, including interpreting applicable DOE Orders, regulations, and guidance into criteria for in vivo measurement frequency, etc., for the plant-wide whole body counting services; state-of-the-art facilities and equipment used to provide the best in vivo measurement results possible for the approximately 11,000 measurements made annually; procedures for performing the various in vivo measurements at the Whole Body Counter (WBC) and related facilities including whole body counts; operation and maintenance of counting equipment, quality assurance provisions of the program, WBC data processing functions, statistical aspects of in vivo measurements, and whole body counting records and associated guidance documents. 16 refs., 48 figs., 22 tabs.

41708 (PNL-7410-HEDR) **Phase 1 of the Hanford Environmental Dose Reconstruction Project: Draft summary report.** Pacific Northwest Lab., Richland, WA (USA). 20 Jul 1990. 96p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC06-76RL01830. Order Number DE90014617. Available from NTIS, PC A05/MF A01 - OSTI; GPO Dep.

For more than 40 years, the US government made plutonium for nuclear weapons at the Hanford Site in southeastern Washington State. Radioactive materials were released to both the air and water from Hanford. People could have been exposed to these materials, called radionuclides. The Hanford Environmental Dose Reconstruction (HEDR) Project is a multi-year scientific study to estimate the radiation doses the public may have received as a results of these releases. The study began in 1988. During the first phase, scientists began to develop and test methods for reconstructing the radiation doses. To do this, scientists found or reconstructed information about the amount and type of radionuclides that were released from Hadford facilities, where they traveled in environment, and how they reached people. Information about the people who could have been exposed was also found or reconstructed. Scientists then developed a computer model that can estimate doses from radiation exposure received many years ago. All the information that had been gathered was fed into the computer model. Then scientists did a "test run" to see whether the model was working properly. As part of its "test run," scientists asked the computer model to generate two types of preliminary results: amounts of radionuclides in the environment (air, soil, pasture grass, food, and milk) and preliminary doses people could have received from all the routes of radiation exposure, called exposure pathways. Preliminary dose estimates were made for categories of people who shared certain characteristics and for the Phase 1 population as a whole. 26 refs., 48 figs.

41709 (PNL-7412-HEDR) **Phase 1 of the Hanford Environmental Dose Reconstruction Project: Draft air pathway report.** Pacific Northwest Lab., Richland, WA (USA). 20 Jul 1990. 270p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC06-76RL01830. Order Number DE90014616. Available from NTIS, PC A12/MF A01 - OSTI; GPO Dep.

This report summarizes the air pathway portion of the first phase of the Hanford Environmental Dose Reconstruction (HEDR)

Project, conducted by Battelle staff at the Pacific Northwest Laboratory under the direction of an independent Technical Steering Panel. The HEDR Project is estimating historical radiation doses that could have been received by populations near the Department of Energy's Hanford Site, in southeastern Washington State. Phase 1 of the air-pathway dose reconstruction sought to determine whether dose estimates could be calculated for populations in the 10 counties nearest the Hanford Site from atmospheric releases of iodine-131 from the site from 1944–1947. Phase 1 demonstrated the following: HEDR-calculated source-term estimates of iodine-131 releases to the atmosphere were within 20% of previously published estimates; calculated vegetation concentrations of iodine-131 agree well with previously published measurements; the highest of the Phase 1 preliminary dose estimates to the thyroid are consistent with independent, previously published estimates of doses to maximally exposed individuals; and relatively crude, previously published measurements of thyroid burdens for Hanford workers are in the range of average burdens that the HEDR model estimated for similar "reference individuals" for the period 1944–1947. 4 refs., 10 figs., 9 tabs.

41710 (RERF-CR–1-89) **An overview of the cancer mortality data on the atomic bomb survivors.** Pierce, D.A. Radiation Effects Research Foundation, Hiroshima (Japan). Nov 1989. 12p. Order Number DE90508015. Available from NTIS (US Sales Only), PC A03/MF A01.

A brief description is given of the cancer mortality data at the Radiation Effects Research Foundation, with the aim of providing some general perspective on the extent of the excess cancer mortality, for those who may not be inclined to glean this information from the more comprehensive reports on the Life Span Study. In addition, a summary is given of the changes in dosimetry given by the recently installed DS86 system. Even a cursory view of these changes requires consideration of several factors; changes in air doses, in environmental and organ shielding factors, in the extent of the neutron component, and in effects of truncation of exposures at 6 Gy. Finally, a brief discussion is given of the evolution of radiogenic cancer risk estimates during the past 10-15 years. (author).

41711 (RERF-CR–2-89) **Cancer risk estimation from the A-bomb survivors: Extrapolation to low doses, use of relative risk models, and other uncertainties.** Pierce, D.A.; Vaeth, M. Radiation Effects Research Foundation, Hiroshima (Japan). Oct 1989. 17p. Order Number DE90508013. Available from NTIS (US Sales Only), PC A03/MF A01.

Generalizations regarding radiogenic cancer risks from the A-bomb survivor data of the Radiation Effects Research Foundation involve a large number of well-identified uncertainties and approximations. These include extrapolation to low doses and dose rates, projections in time, sampling variation, the quality of the data, extrapolation to other populations, and the use of simplifying conventions. This paper discusses some of these issues, with emphasis on the first three. Results are given regarding the maximum 'linear-quadratic' curvature consistent with these data, taking into account uncertainties in individual exposure estimates. Discussion is given regarding use of relative risk models and projection of lifetime risks, emphasizing results for those who were old enough at exposure to have been followed up for a major part of their lives by now, and stressing the speculative aspects of conclusions about those exposed as children. Combining these results, and brief discussion of other uncertainties itemized above, comment is made on the evolution of risk estimates over the past 15 years. (author).

41712 (RERF-TR–6-89) **Expression of proto-oncogenes in non-Hodgkin's lymphomas by in situ hybridization with biotinylated DNA probes.** Hamatani, Kiyohiro; Yoshida, Kuniko; Abe, Masumi; Shimaoka, Katsutaro; Shiku, Hiroshi; Akiyama, Mitoshi; Kondo, Hisayoshi. Radiation Effects Research Foundation, Hiroshima (Japan). Nov 1989. 18p. Order Number DE90508007. Available from NTIS (US Sales Only), PC A03/MF A01.

Expression of six proto-oncogenes (fos, myc, myb, Ki-ras, Ha-ras, and N-ras) in 43 cases of non-Hodgkin's lymphoma was analyzed by means of in situ hybridization. Biotinylated DNA probes of the six oncogenes and those of the immunoglobulin H-chain (IgH) gene and the T cell receptor β-chain (TCRβ) gene were used. The results of in situ hybridization performed under blind conditions by IgH and TCRβ gene probes were compatible with those of typing by cell surface markers. The nuclear protein-related proto-oncogenes, fos myc, and myb, were expressed in about 70 % - 80 % of all cases regardless of phenotypes, histology or histologic grade. On the contrary, genes of the ras family were expressed in fewer cases except for the Ki-ras gene which was more frequently expressed by cases of the T cell immunophenotype with a high malignancy grade. The results of dot hybridization with RNA extracted from some cases were compatible with those of in situ hybridization, further demonstrating the specificity of in situ hybridization. (author).

41713 (RERF-TR–10-89) **Abdominal ultrasonographic screening of adult health study participants.** Russell, W.J. (and others); Higashi, Yoshitaka; Fukuya, Tatsuro. Radiation Effects Research Foundation, Hiroshima (Japan). Nov 1989. 19p. Order Number DE90508011. Available from NTIS (US Sales Only), PC A03/MF A01.

To assess ultrasonography's capabilities in the detection of cancer and other diseases, abdominal ultrasonographic screening was performed for 3,707 Hiroshima and 2,294 Nagasaki atomic bomb survivors and comparison subjects who participated in the Adult Health Study from 1 November 1981 to 31 October 1985 in Hiroshima and from 1 August 1984 to 31 July 1986 in Nagasaki. A total of 20 cancers was detected, consisting of 7 hepatomas, 3 gastric cancers, 3 renal cancers, 2 cancers of the urinary bladder, and 1 cancer each of the ovary, pancreas, colon, ureter and liver (metastatic). The cancer detection rate was 0.33 %. The diagnoses of seven cancer subjects in each city were subsequently confirmed at autopsy or surgery; diagnoses of four cancer subjects in Hiroshima and two in Nagasaki were obtained from death certificates. Among the 20 cancer patients, 13 were asymptomatic. After the ultrasonographic detection and diagnosis of these 20 cancers, the medical records of each of the 20 cancer patients were reviewed for any evidence of cancer detection by other examining techniques, and the records of only 3 patients revealed such recent detection. The tumor and tissue registries were similarly checked, but no evidence of earlier diagnosis of their disease was found. Ten of the cancer patients had received ionizing radiation doses from the A-bombs ranging up to 3,421 mGy (DS86), but no correlation was established between cancer prevalence and the A-bomb doses. A variety of tumors, 259 in number and most probably benign, were also detected with ultrasonography. In addition, numerous other abnormalities were diagnosed, with prevalences of 7.7 % for cholelithiasis, 5.7 % for renal cysts, and 3.8 % for liver cysts. No statistical analysis was performed concerning the prevalence of the diseases detected. (author).

41714 (RERF-TR–15-89) **Is variation in human radiosensitivity real or artifactual?: A study by colony formation method using peripheral blood T-lymphocytes.** Nakamura, Nori; Kushiro, Jun-ichi; Sposto, R.; Akiyama, Mitoshi. Radiation Effects Research Foundation, Hiroshima (Japan). Dec 1989. 13p. Order Number DE90508005. Available from NTIS (US Sales Only), PC A03/MF A01.

Two methods of producing human T-lymphocyte colonies in vitro are described, as well as dose-survival experiments using these methods for the investigation of possible differential radiosensitivity among individuals. In one method, the cloning efficiency (CE) of nonirradiated lymphocytes was between 10 % and 40 % (method 1), whereas subsequent improvement in assay conditions (method 2) resulted in a CE greater than 30 %. In vitro X-irradiation of colonies produced using method 1 revealed that the dose required to kill 90 % of the cells (D_{10}) was 2.87$\pm$0.28 Gy (mean $\pm$SD, n = 18) for repeated examinations of lymphocytes from one reference individual. Using method 2, the D_{10} values were greater, viz., 3.66$\pm$0.21 Gy for 28 repeated tests of the same reference individual and 3.58$\pm$0.19 Gy for 31 different individuals. Analysis of variance to compare the data from repeated examinations of one person versus data from single examinations of different persons showed that variation in the D_{10} value was not significantly greater in the latter group. These results support the hypothesis that individual variation in human radiosensitivity is quite small, if it exists at all, as far as can be determined by the loss of colony-forming ability of irradiated G_0 lymphocytes. (author).

41715 (RERF-TR-16-89) **Radiosensitivity of CD4 and CD8 positive human T lymphocytes by an in vitro colony formation assay.** Nakamura, Nori; Kusunoki, Yoichiro; Akiyama, Mitoshi. Radiation Effects Research Foundation, Hiroshima (Japan). Dec 1989. 9p. Order Number DE90508009. Available from NTIS (US Sales Only), PC A02/MF A01.

The recent development of an in vitro lymphocyte colony assay provides a new opportunity to examine possible variations in human radiosensitivity using peripheral blood lymphocytes (PBL) in place of the hitherto used skin fibroblast assay. Our recent study showed that most of the colonies consisted of lymphocytes bearing CD4 or CD8 antigens. Since the fraction of $CD4^+$ and $CD8^+$ cells in PBL differs among individuals, it was suspected that individual radiosensitivity might be biased by the different subset frequencies if the dose-survival curves of the $CD4^+$ and $CD8^+$ cells differed. In the present study, $CD4^+$ lymphocytes (helper/inducer T cells) and $CD8^+$ lymphocytes (suppressor/cytotoxic T cells) were isolated from PBL and their dose-survival curves were determined. The results showed that the D_{10} (the dose required to reduce the surviving fraction to 10 %) was quite similar for these two types of cells (3.13 $\pm$ 0.10 Gy [mean $\pm$SD] for $CD4^+$, 3.34 $\pm$ 0.50 Gy for $CD8^+$ and 3.07 $\pm$ 0.05 Gy for the unsorted cells), supporting the use of a whole PBL population for screening of individuals with altered radiosensitivity. (author).

41716 **Inhalation carcinogenesis of repeated exposures to high-fired $^{244}CmO_2$ in rats.** Sanders, C.L. (Pacific Northwest Laboratory, Richland, WA (USA)); Mahaffey, J.A. *Health Physics (USA)*, 58(5): 631-638 (May 1990).

Rats were given single or multiple (10 exposures at about 21-d intervals) inhalation exposures to $^{244}CmO_2$ starting at 70 d of age. Mean lung and bone doses (+/- standard deviation) were 1.4 +/- 1.3 and 0.74 +/- 1.1 Gy, respectively, in the single exposure group, and 1.8 +/- 2.9 and 0.53 +/- 0.74 Gy, respectively, in the multiple exposure group. After cessation of exposure in the multiple exposure group, mean cumulative lifetime radiation doses to lung and skeleton were not significantly different in the two groups. The percentages of rats with lung and bone tumors were 9.1 and 12%, respectively, in the single exposure group, and 20 and 24%, respectively, in the multiple exposure group. However, the multiple exposure regimen did not significantly alter survival times or tumor incidences in lung or bone from a single inhalation exposure to $^{244}CmO_2$ when survival patterns were taken into account.

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Refer also to citation(s) 40351, 40352, 40362, 40868, 41527, 41539, 41552, 41569, 41570, 41603, 41606, 41607, 41610, 41627, 41632, 41640, 41653, 41658, 41662, 41666, 41667

41717 (CONF-891098-8) **Impact, hazard, and risk assessment of toxic effects on nonhuman organisms.** Suter, G.W. II. Oak Ridge National Lab., TN (USA). [1989]. 16p. Sponsored by U.S. Department of Defense. DOE Contract AC05-84OR21400. From The scientific challenges of NEPA: future directions based on 20 years of experience; Knoxville, TN (USA); 24-27 Oct 1989. Order Number DE90014204. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

When the National Environmental Policy Act (NEPA) was enacted, environmental toxicology was nearing the end of a long infancy. Toxicity testing procedures were not standardized, testing was almost entirely limited to determining lethal effects of acute exposures of fully developed organisms, and there was no assessment paradigm for effective use of test data. The requirement of NEPA that all effects of major federal actions be predicted and disclosed presented a major challenge. However, environmental toxicity assessments for NEPA did not generate improvements in either toxicology or assessment techniques. Instead, assessment dealt with chemical emissions largely in terms of their compliance with standards and permits. This paper presents of argument that this approach is not adequate and that ecological risk assessment is the best approach for assessing toxicological effects under NEPA. 21 refs., 2 figs.

41718 (CONF-9006231-1) **Health hazards in the glass shop.** Myers, G.E.; Gregar, J.S. Argonne National Lab., IL (USA). [1990]. 13p. Sponsored by U.S. DOE Energy Research. DOE Contract W-31109-ENG-38. From ASGS '90: American scientific glassblowers society conference; Orlando, FL (USA); 25-29 Jun 1990. Order Number DE90013660. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Since the beginning of the Occupational Safety and Health Administration, commonly referred to as OSHA, there have been fewer resources devoted to safety in the small workplace than to workers in larger plants and factories. Many glassblowers are among those who must educate themselves about safe work practices through special organizations and individual interest. Many materials frequently used throughout the glass industry have recently been found to be hazardous. Many commonly used articles and chemicals found in the glass shop may not be safe even though you have used them for years. This document discusses the health hazards and pathways of organic solvents and other hazardous materials used in the glass industry. Also included are safety precautions and preventive actions to be followed.

41719 (CONF-9006234-2) **Access and use of information resources in assessing health risks from chemical exposure.** Kaye, S.V. Oak Ridge National Lab., TN (USA). 27 Jun 1990. 2p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. From Symposium on access and use of information resources in assessing health risks from chemical exposure; Oak Ridge, TN (USA); 27-29 Jun 1990. Order Number DE90014220. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Short communication. HAZARDOUS MATERIALS/health hazards; HAZARDOUS MATERIALS/information needs; HUMAN POPULATIONS/environmental exposure; RISK ASSESSMENT; MEETINGS; CHRONIC EXPOSURE; ENVIRONMENTAL POLICY; TOXICITY

41720 (ORNL/M-1207) **Symposium on access and use of information resources in assessing health risks from chemical exposure.** Oak Ridge National Lab., TN (USA). [1990]. 14p. Sponsored by U.S. DOE Energy Research; Environmental Protection Agency. DOE Contract AC05-84OR21400. (CONF-9006234-Suppl.: Symposium on access and use of information resources in assessing health risks from chemical exposure, Oak Ridge, TN (USA), 27-29 Jun 1990). Order Number DE90013248. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This document contains information on health hazards from chemical exposure. Included is the agenda from the symposium held June 27–29, 1990 and a list of poster sessions and demonstrations. (KJD)

41721 (ORNL/M-1211) **TNT metabolites in animal tissues: Quarterly technical progress report (No. 7), April 1, 1990–June 30, 1990.** Shugart, L.R. Oak Ridge National Lab., TN (USA). Jul 1990. 10p. Sponsored by U.S. Department of Defense. DOE Contract AC05-84OR21400. Order Number DE90014698. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

This report document researches activities from April 1, 1990–June 30, 1990. The overall objectives of this project are: to provide quantitative analytical procedures for the analysis of TNT and at least eight of its metabolites in animal tissues, and to obtain representative samples of tissues from animals from designated Army sites, and to determine the presence or absence of TNT and its metabolites in these samples. The study is divided into two Phases corresponding to the stated overall objectives of the project. 2 figs., 2 tabs.

41722 (PB-90-192774/XAB) **National dioxin study-Phase 2. Analytical procedures and quality-assurance plan for the determination of PCDD/PCDF in fish.** Environmental Protection Agency, Duluth, MN (USA). Environmental Research Lab. Mar 1990. 40p. (EPA-600/3-90/022). Available from NTIS, PC A03/MF A01.

See also PB-90-192782.

The report describes the analytical procedures and quality assurance plan used for the determination of polychlorinated dibenzo-p-dioxins and dibenzofurans in fish for Phase II of the U.S. EPA National Dioxin Study. These methods are based upon

compound identification and quantification by gas chromatography-mass spectrometry.

41723 (PB–90-211665/XAB) **Federal regulatory response to the problem of neurotoxicity.** Courteau, J.B.; Young, J.S. Hampshire Research Associates, Alexandria, VA (USA). Dec 1988. 110p. Available from NTIS, PC A06/MF A01.

The purpose of the chapter is to examine the Federal regulatory response to the control of neurotoxicants. The first section presents an overview of legislation and regulations designed to protect the public from toxic substances and of the specific ways in which the statutes and regulations apply to controlling neurotoxic chemicals. Subsequent sections present the regulatory process in greater detail, describing how information on toxic effects is gathered and evaluated, and outlining some new initiatives in regulating neurotoxins. The chapter concludes with a discussion of the consistency and adequacy of the Federal regulatory framework.

41724 (PB–90-215914/XAB) **Predictions of ozone absorption in human lungs from newborn to adult.** Overton, J.H.; Graham, R.C. Northrop Services, Inc., Research Triangle Park, NC (USA). ©1989. 10p. Available from NTIS, PC A02/MF A01.

Pub. in Health Physics, Vol. 57, Sup.1, 29-36(Nov 1989).

Dosimetry models for gases mainly have been used to predict absorption in adult humans and laboratory animals. The lack of lower respiratory tract (LRT) lung models for children has discouraged the application of theoretical gaseous dosimetry to this important sub-population. To fill this gap the authors have used several sources of data on age dependent LRT volumes, age dependent airway dimensions, a model of an adult tracheobronchial region, and a model of the adult acinus to construct theoretical LRT lung models for humans from birth to adult. An ozone (O_3) dosimetry model was then used to estimate the regional and local uptake of O_3 in the (theoretical) LRTs of children and adults. For sedentary breathing, the LRT distribution of absorbed O_3, the percent uptake (76 to 85%), and the centriacinar O_3 tissue dose are not very sensitive to age. For maximal work during exercise, predicted uptakes range from 83 to 91%, and the regional percent uptakes are more dependent on age than during quiet breathing. In general, total O_3 absorption per minute increases with age. Regardless of age and state of breathing, the largest tissue dose of O_3 is predicted to occur in the centriacinar region, where many animal studies show the maximal morphological damage due to O_3.

41725 (PB–90-216003/XAB) **Critical issues in intra- and interspecies dosimetry of ozone.** Miller, F.J.; Overton, J.H. Environmental Protection Agency, Research Triangle Park, NC (USA). Health Effects Research Lab. ©1989. 13p. (EPA–600/J-89/359). Available from NTIS, PC A03/MF A01.

Pub. in Atmospheric Ozone Research and Its Policy Implications, 281-291(1989).

Knowledge of dose at the target site is a fundamental starting point in making interspecies dosimetric comparisons. To the extent that information is available on the effective dose of a compound, the confidence in risk assessments is increased. To facilitate judgments about effects determined in animals relative to likelihood of risk associated with human exposure to ozone (O3), a mathematical dosimetry model has been developed for interspecies comparisons. The model incorporates the major factors affecting the absorption of O3 in the respiratory tract: the morphology of the respiratory tract, the route, depth and rate of breathing, physicochemical properties of O3, the physical and chemical processes which govern gas transport, and the physicochemical properties of the lining fluids and tissue material of the airways and gas exchange units. Also discussed are the application of the dosimetry model for examining age-dependent susceptibility to O3 and the potential usefulness of such models for relating microdosimetry to microtoxicology.

41726 (PB–90-216110/XAB) **Human health effects assays.** Fradkin, L.; Sonich-Mullin, C.; Cerny, M.; Kruger, C.; Cavender, F. Environmental Protection Agency, Cincinnati, OH (USA). Office of Environmental Criteria and Assessment. ©1989. 8p. (EPA–600/J-89/349). Available from NTIS, PC A02/MF A01.

Pub. in Jnl. Water Pollution Control Federation, Vol. 61, No. 6, 1072-1077(1989).

The use of assays to evaluate and assist in predicting potentially adverse human health effects associated with exposure to pollutants in water (that is, municipal wastewater, sewage sludge, ambient water, and drinking water) is the focus of the review.

41727 (PB–90-216144/XAB) **Toxicological evaluation of complex industrial wastes: Implications for exposure assessment.** DeMarini, D.M.; Gallagher, J.E.; Houk, V.S.; Simmons, J.E. Environmental Protection Agency, Research Triangle Park, NC (USA). Health Effects Research Lab. ©1989. 18p. (EPA–600/J-89/385). Available from NTIS, PC A03/MF A01.

Pub. in Toxicology Letters, Vol. 49, 199-214(Oct 1989).

A variety of short-term bioassays to construct a battery of tests that could be used for assessing the biological effects of potentially hazardous complex industrial wastes were evaluated. Ten samples were studied for hepatotoxicity: These samples and an additional five were studied for mutagenicity. Although the data are limited to these samples, the results suggest that the Salmonella assay (either TA98 or TA100) or a prophage-induction assay (both in the presence of S9) in combination with determination of relative liver weight and levels of a set of serum enzymes in rats would provide a battery of tests suitable to characterize complex industrial wastes for mutagenic and hepatotoxic potential. The biological activities exhibited by the wastes were not readily predicted by the chemical profiles of the wastes, emphasizing the importance of characterizing potentially hazardous complex industrial wastes by both chemical and biological means.

41728 (PB–90-216243/XAB) **Health effects of ozone: A critical review.** Lippmann, M. New York Univ., NY (USA). Inst. of Environmental Medicine. ©1989. 26p. Available from NTIS, PC A03/MF A01.

Pub. in Jnl. of the Air Pollution Control Association, Vol. 39, No. 5, 672-695(May 1989).

Health and pollution control professionals and the general public need to develop a more complete understanding of the health effects of ozone (O3) because it has not been possible to significantly reduce ambient O3 levels using current strategies and control. In areas occupied by more than half of the US population, current peak ambient O3 concentrations are sufficient to elicit measurable transient changes in lung function, respiratory symptoms, and airway inflammation in healthy people engaged in normal outdoor exercise and recreational activities; the effects of O3 on transient functional changes are sometimes greatly potentiated by the presence of other environmental variables; and emulative structural damage occurs in rats and monkeys exposed repetitively to O3 at levels within currently occurring ambient peaks, and initial evidence from dosimetry models and interspecies comparisons indicate that humans are likely to be more sensitive to O3 than rats. The extent and significance of these effects, and the multibillion dollar costs of ambient O3 controls need to be considered in any future revisions of ambient standards and the Clean Air Act. The transient effects of O3 are more closely related to cumulative daily exposure than to one hour peak concentrations, and future revisions of the ambient standard for O3 should take this into account.

41729 (PB–90-216359/XAB) **Effects of ozone on the regrowth and energy reserves of a ladino clover-tall fescue pasture.** Rebbeck, J.; Blum, U.; Heagle, A.S. North Carolina State Univ., Raleigh, NC (USA). ©1988. 24p. Available from NTIS, PC A03/MF A01.

Pub. in Jnl. of Applied Ecology 25, 659-681(1988).

A ladino clover and tall fescue pasture was established in September 1983 to determine the impact of ozone and available soil moisture on plants grown in open-top field chambers and exposed for 12 h daily to ozone (O_3) from April through October in 1984 and 1985. Samples were removed periodically to measure above- and below-ground biomass and energy reserves of the clover and fescue. At the final harvest, clover was the dominant species in below-ambient O_3 while fescue was the dominant species at ambient and above-ambient O_3 concentrations. Ladino clover shoot and root biomass was reduced by O_3 for all harvest when compared to clover grown in the charcoal-filtered-air. Statistically-significant O_3 effects were observed on clover shoots prior to roots. For most harvests, the energy reserves of ladino clover roots were suppressed by increasing O_3 concentrations.

Clover shoot starch levels were not greatly affected by O_3 or moisture.

41730 (PB–90-216375/XAB) **Effects of long-term ozone exposure and soil-moisture deficit on growth of a ladino clover-tall fescue pasture.** Heagle, A.S.; Rebbeck, J.; Shafer, S.R.; Blum, U.; Heck, W.W. Environmental Protection Agency, Corvallis, OR (USA). Environmental Research Lab. ©1988. 11p. (EPA–600/J-88/512). Available from NTIS, PC A03/MF A01.

Pub. in Phytopathology, Vol. 79, No. 2, 128-136(1988).

Most field studies relating seasonal ozone (O3) exposure to crop yield have been performed in the absence of plant moisture stress. The authors examined the response of a mixture of ladino clover and tall fescue to chronic doses of O3 at two soil-moisture levels over two growing seasons. The soil-moisture treatments, obtained by differential irrigation, were well-watered or water-stressed. A soil-moisture deficit occurred intermittently in water-stressed plots during both seasons. Shoots were harvested when plants reached a height of 20-25 cm. Total forage yield in the water stressed plots was 12-14% less than that in the well-watered plots. Clover was much more sensitive than fescue to O3. The decrease in total forage yield and decreased quality caused by decreased growth of clover suggest a need for ladino clover lines that are tolerant to O3.

41731 (PB–90-216896/XAB) **National Toxicology Program annual plan for Fiscal Year 1989.** National Toxicology Program, Research Triangle Park, NC (USA). Jun 1989. 275p. (NTP–89-167). Available from NTIS, PC A12/MF A02.

See also report for 1988, PB–89-143309.

The NTP serves Federal health regulatory and research agencies as well as others concerned with public health. Its role is a logical extension of the Public Health Service's responsibility for safeguarding the public's health, and for responding to the fundamental public health precept of preventing unnecessary exposure to hazards. In order to strengthen and coordinate toxic chemical research and testing, the NTP is charged with: (1) broadening the spectrum of toxicologic information obtained on selected chemicals; (2) increasing the numbers of chemicals studied, within funding limits; (3) developing and validating assays and protocols responsive to regulatory needs; and (4) communicating Program plans and results to governmental agencies, the medical and scientific communities, and the public. The annual plan discusses 1989 activities within the scope of the responsibilities mentioned.

41732 (PB–90-216904/XAB) **National Toxicology Program: Review of current DHHS, DOE, and EPA research related to toxicology, Fiscal Year 1989.** National Toxicology Program, Research Triangle Park, NC (USA). Nov 1989. 359p. (NTP–89-168). Available from NTIS, PC A16/MF A02.

See also report for 1988, PB–89-143291.

The review covers projections for Fiscal Year 1989, made by October, 1988, and based on the President's proposed budget. It represents responses by agencies of DHHS, and by DOE and EPA, to requests by the director of NTP for information on agency programs in basic toxicology research, toxicology testing, and toxicology methods development. Although the review covers thoroughly the activities of critical components of DHHS, DOE, and EPA in support of toxicology-related research, it does not include information on related activities supported by other Federal agencies such as the Department of Agriculture, the Department of Commerce, the Department of Interior, and the Department of Defense.

41733 (PB–90-217316/XAB) **Public knowledge and perceptions of chemical risks in six communities: Analysis of a baseline survey. Final report on Phase 1.** McCallum, D.B.; Hammond, S.L.; Morris, L.A.; Covello, V.T. Georgetown Univ. Medical Center, Washington, DC (USA). Jan 1990. 178p. Available from NTIS, PC A09/MF A01.

A survey of public knowledge and perceptions of chemical risk was conducted in six communities. The purpose was to establish a baseline for evaluating change over time in knowledge, attitudes, and behaviors in response to new information about toxic chemicals, especially as related to Superfund, the Community Right-to-Know Law (SARA Title III), and other risk communication activities. During July and August, 1988, over 500 citizens responded to a 25-minute telephone survey in each city: Albuquerque NM, Cincinnati, OH, Durham NC, Middlesex County NJ, Racine WI, and Richmond VA. The report provides an overview of how citizens in these communities view environmental risks, and how the communities differ in their basic knowledge and attitudes about such risks. Recommendations are provided, for use in preparing risk communication programs and materials.

41734 (PB–90-217423/XAB) **Evaluation of a finite multipole expansion technique for the computation of electrostatic potentials of dibenzo-p-dioxins and related systems.** Murray, J.S.; Grice, M.E.; Politzer, P.; Rabinowitz, J.R. New Orleans Univ., LA (USA). Dept. of Chemistry. ©1990. 11p. Available from NTIS, PC A03/MF A01.

Pub. in Jnl. of Computational Chemistry, Vol. 11, No. 1, 112-120(Jan 1990).

The electrostatic potential V(r) that the nuclei and electrons of a molecule create in the surrounding space is well established as a guide in the study of molecular reactivity, and particularly, of biological recognition processes. Its rigorous computation is, however, very demanding of computer time for large molecules, such as those of interest in recognition interactions. The authors have accordingly investigated the use of an approximate finite multicenter multipole expansion technique to determine its applicability for producing reliable electrostatic potentials of dibenzo-p-dioxins and related molecules, with significantly reduced amounts of computer time, at distances of interest in recognition studies. A comparative analysis of the potentials of three dibenzo-q-dioxins and a substituted naphthalene molecule computed using both the multipole expansion technique and GAUSSIAN 82 at the STO-5G level has been carried out. Overall they found that regions of negative and positive V(r) at 1.75 A above the molecular plane are very well reproduced by the multipole expansion technique, with up to a twenty-fold improvement in computer time.

41735 (PB–90-217563/XAB) **Circulating factors that modify lung-cell DNA synthesis following exposure to inhaled oxidants. II. Effect of serum and lavage on lung pneumocytes following exposure of adult rats to 1 ppm ozone.** Tanswell, A.K.; Fraher, L.J.; Grose, E.C. Environmental Protection Agency, Research Triangle Park, NC (USA). Health Effects Research Lab. ©1990. 16p. (EPA–600/J-90/038). Available from NTIS, PC A03/MF A01.

Pub. in Jnl. of Toxicology and Environmental Health, Vol. 29, 131-144(Jan 1990).

Adult rats were exposed to 1 ppm (1.96 mg/cu m) ozone or air for 2 weeks. Animals were sacrificed at 3, 5, 7 or 14 days after the onset of exposure and samples of plasma and lung lavage obtained. Heat inactivated plasma and lavage from animals exposed to ozone, for 5 or 7 days, significantly increased DNA synthesis by lung fibroblasts compared with plasma or lavage from air exposed animals. Fractionation of plasma and lavage samples indicated that the factor responsible had an isoelectric point of 6.45-6.75, and a molecular weight of 38 + or - 3 Kd. This factor has a dose-dependent effect on lung pneumocyte DNA synthesis in culture. It has no effect on cultured fibroblast DNA synthesis, and is distinct from a previously described factor in the plasma of these ozone-exposed animals which enhances fibroblast DNA synthesis. The factor is detectable within 5 days of exposure, and may hold some promise as a marker of early oxidant lung injury.

41736 (PB–90-217654/XAB) **Influence of salinity and temperature on acute toxicity of cadmium to Mysidopsis bahia molenock.** Voyer, R.A.; Modica, G. Environmental Protection Agency, Narragansett, RI (USA). Environmental Research Lab. ©1990. 10p. (ERLN–950). Available from NTIS, PC A02/MF A01.

Pub. in Archives of Environmental Contamination and Toxicology, Vol. 19, 124-131(1990).

Acute toxicity tests were conducted to compare estimates of toxicity, as modified by salinity and temperature, based on response surface techniques with those derived using conventional test methods, and to compare effect of a single episodic exposure to cadmium as a function of salinity with that of continuous exposure. Regression analysis indicated that mortality following continuous 96-hr exposure is related to linear and quadratic effects of salinity and cadmium at 20 C, and to the linear and quadratic effects of

cadmium only at 25C. LC50s decreased with increases in temperature and decreases in salinity. Based on the regression model developed, 96-hr LC50s ranged from 15.5 to 28.0 micro Cd/L at 10 and 30% salinities, respectively, at 25C; and from 47 to 85 microgram Cd/L at these salinities at 20C.

41737 (PB–90-219346/XAB) **Technical assistance to the Ohio Department of Health. Volatile organic compound testing of blood of persons living near the Industrial Excess Landfill NPL site, Uniontown, Ohio. Final report.** Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). Jun 1988. 18p. (ATSDR/HS–90/02). Available from NTIS, PC A03/MF A01.

Errata sheet inserted.

The Epidemiology and Medicine Branch (EMB) of the Agency for Toxic Substances and Disease Registry (ATSDR) was requested by the Ohio Department of Health (ODH) to assist in evaluating volatile organic compound (VOC) exposures of persons residing near the Industrial Excess Landfill site in Uniontown, Ohio, and who had prior privately obtained tests. The purpose of the testing was to evaluate the concern that prior tests might indicate unusual VOC exposures. EMB proposed to perform an investigation that would survey the community near the landfill for self-reported diseases and health complaints and to provide some blood testing. The proposal was declined by a committee representing the affected citizens until a health assessment can be completed wherein routes of contamination from the landfill are established. The blood testing was performed on these privately evaluated people on a voluntary basis, and 13 of the 16 chose to participate. The VOC test results were within established norms for all but two participants. These two had high levels of tetrachloroethene. Also reported was the presence of a 6-carbon, 14-hydrogen compound. The level of the compound could not be quantitated because of the absence of laboratory validation standard materials.

41738 (PB–90-219676/XAB) **Ozone effects on agricultural crops: Statistical methodologies and estimated dose-response relationships.** Lesser, V.M.; Rawlings, J.O.; Spruill, S.E.; Somerville, M.C. Environmental Protection Agency, Corvallis, OR (USA). Environmental Research Lab. ©1990. 10p. (EPA–600/J-90/007). Available from NTIS, PC A02/MF A01.

Pub. in Crop Science, Vol. 30, 148-155(1990).

The National Crop Loss Assessment Network (NCLAN) began in 1980 to coordinate research on the investigation of the impact of ozone on agricultural crops. A major objective was to develop dose-response relationships between yield of major agricultural crop species and ozone pollution in order to estimate the economic effects of ozone. The paper reports on the statistical methodologies used in combining the dose-response information for each species over sites and years, and serves as a summary of the ozone dose-response relationships obtained from the NCLAN studies. All dose-response relationships between yield and ozone were characterized with the polynomial response function and the nonlinear Weibull response function. The paper presents the general methodology for both models and the dose response equations for the Weibull model.

41739 (PB–90-220468/XAB) **Silver Creek Mine tailings exposure study, Park City, Utah. Final report.** Amler, R.W.; Baburich, S.B.; Jones, P.A.; Kaye, W.E.; Lybarger, J.A. Agency for Toxic Substances and Disease Registry, Atlanta, GA (USA). Jun 1988. 95p. (ATSDR/HS–90/07). Available from NTIS, PC A05/MF A01.

A human exposure study was conducted to determine the effect of mine tailings contaminated with lead, arsenic, and cadmium (Silver Creek Mine Tailings Site, Utah) on biological levels of these elements among persons living in the immediate vicinity. Cross-sectional data were collected from the target area and from a comparison area located off site. Biological measurements included blood lead, erythrocytic protoporphyrin, hemoglobin, urine beta-2-microglobulin, urine arsenic, and urine cadmium (adjusted to urine creatinine and specific gravity). In addition, all participants were surveyed to identify independent or potentially confounding factors that might influence the measurements. There was no evidence of excess exposure to lead, arsenic, or cadmium at clinically meaningful levels among residents living on or adjacent to the site. Although blood lead levels were higher in the target area than in the comparison area among children 9-71 months of age, the differing values were within the normal range. Further, the mean blood lead levels for both areas were well below the national mean levels (1976-1980) for this age group. Other behavioral factors found to increase blood lead levels in this age group were identified.

41740 (PB–90-225954/XAB) **Review of current research and activities involving characterization, abatement, and disposal of lead-containing paint films.** McKnight, M.E. National Inst. of Standards and Technology (NEL), Gaithersburg, MD (USA). Building Materials Div. May 1990. 14p. (NISTIR–90/4285). Available from NTIS, PC A03/MF A01.

In response to a recent regulation for abating lead-based paint in housing and other environmental regulations, research projects and other activities are being conducted to provide information on procedures for carrying out abatement and maintenance of lead-containing paint films in a safe and cost-effective manner. Relevant Federal regulations, and current research projects and other activities addressing the issues are reviewed.

41741 (PB–90-869447/XAB) **Chromium toxicity. January 1987-April 1990 (A Bibliography from the Life Sciences Collection data base). Report for January 1987-April 1990.** National Technical Information Service, Springfield, VA (USA). May 1990. 50p. Available from NTISPC N01/MF N01.

Supersedes PB–89-860803.

This bibliography contains citations concerning the biological effects of chromium exposure. The effects on protein metabolism and kidney and liver functions are discussed, and the role of chromium as a carcinogenic agent and its antigenicity are also considered. Sources of chromium contamination including occupational exposure and pollution are discussed, and methods of analysis are described. (This updated bibliography contains 96 citations, 37 of which are new entries to the previous edition.)

41742 (PB–90-870114/XAB) **Asbestos exposure: Health effects. December 1985-March 1990 (A Bibliography from the Biobusiness data base). Report for December 1985-March 1990.** National Technical Information Service, Springfield, VA (USA). May 1990. 93p. Available from NTISPC N01/MF N01.

Supersedes PB–89-859748.

This bibliography contains citations concerning the health effects of exposure to asbestos in the workplace, at home, and in public sites. Exposure, during procurement of asbestos, removal of asbestos materials, manufacture of materials, and while living and working with materials containing asbestos, is considered. Mortality patterns and clinical studies of exposure, risk, and resulting diseases are presented as well as analytical techniques used to study asbestos health effects. Asbestos removal and abatement questions, and equipment used in these operations are included. (This updated bibliography contains 171 citations, 48 of which are new entries to the previous edition.)

41743 (PB–90-870270/XAB) **Childhood lead exposure hazards. March 1978-February 1990 (A Bibliography from the Life Sciences Collection data base). Report for March 1978-February 1990.** National Technical Information Service, Springfield, VA (USA). May 1990. 139p. Available from NTISPC N01/MF N01.

Supersedes PB–89-858070.

This bibliography contains citations concerning lead (metal) exposure in children and infants and the consequent health effects. Numerous demographic and statistical studies on childhood exposure to lead are presented, as well as prenatal and peripheral exposure that occurs when a family member works in a lead-filled environment. Clinical articles regarding health effects such as impaired learning, hearing loss, the effects on physical development, and anemia are also considered. (This updated bibliography contains 338 citations, 95 of which are new entries to the previous edition.)

41744 (PB–90-870791/XAB) **Hazardous materials: Microbiological decomposition. December 1985-April 1990 (A Bibliography from the Biobusiness data base). Report for December 1985-April 1990.** National Technical Information Service, Springfield, VA (USA). Jun 1990. 52p. Available from NTISPC N01/MF N01.

Supersedes PB–89-857221.

This bibliography contains citations concerning the decomposition of toxic materials by biological means. Bacteria, enzymes, and bioluminescence are among the methods discussed. Bacteria and enzymes that digest toluene, polychlorinated biphenyls (PCBs), selenium wastes, oil shale waste, uranium, oil sludge, pesticides, rubber wastes, and pentachlorophenol are discussed. Flavobacterium and white rot fungus are among the biological agents highlighted. (This updated bibliography contains 88 citations, 32 of which are new entries to the previous edition.)

41745 (PB–90-871393/XAB) **Polychlorinated biphenyls in foods. August 1984-May 1990 (A Bibliography from the Food Science and Technology Abstracts data base). Report for August 1984-May 1990.** National Technical Information Service, Springfield, VA (USA). Jun 1990. 84p. Available from NTISPC N01/MF N01.

Supersedes PB–88-857065.

This bibliography contains citations concerning the presence of polychlorinated biphenyls (PCB) in food products. The toxicology of PCB's, analytical methods to detect and quantitate their presence, and legislation are discussed. The effects on food products, such as meat, fish, fruit, dairy products, and vegetable oils are covered. Packaging materials are also considered. (This updated bibliography contains 173 citations, 66 of which are new entries to the previous edition.)

41746 (PB–90-871732/XAB) **Toxicology and metabolism of methylene chloride. May 1978-February 1990 (A Bibliography from the Life Sciences Collection data base). Report for May 1978-February 1990.** National Technical Information Service, Springfield, VA (USA). Jun 1990. 48p. Available from NTISPC N01/MF N01.

This bibliography contains citations concerning methylene chloride, its effects on biological systems, and its metabolic fate. Both animal and human studies and case reports are examined for methylene chloride toxicity. Exposure to the chemical through inhalation, ingestion, and contact is examined. Occupational exposure to methylene chloride is included, and risk factors are discussed. Long term carcinogenicity of methylene chloride is also considered. Toxicity of other chlorinated organic compounds is referenced in related published bibliographies. (Contains 89 citations fully indexed and including a title list.)

5604 Other Environmental Pollutant Effects

Refer also to citation(s) 41684

41747 (EPRI-EN–6829) **Discussion of an EMF [electric and magnetic field] protocol: Proceedings.** Afifi, A.A. (Banks (Robert S.) Associates, Inc., Minneapolis, MN (USA)); Banks, R.S.; Kheifets, L.I.; Newman, B. Electric Power Research Inst., Palo Alto, CA (USA); Banks (Robert S.) Associates, Inc., Minneapolis, MN (USA). ©Jul 1990. 51p. Sponsored by Electric Power Research Institute. (CONF-8902189–: Discussion of an EMF protocol, Elkridge, MD (USA), 6-8 Feb 1989). Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

In 1989, three collaborating cancer research agencies initiated large-scale case-control studies of the postulated association between residential exposure to 50/60-Hz electric and magnetic fields and the induction of childhood leukemia. To facilitate design of the exposure assessment component of these studies, the Electric Power Research Institute sponsored a two-day workshop on February 6–8, 1989. The workshop's objective was to develop a detailed "state-of-the science" protocol for direct and/or surrogate measurements of a subject's EMF exposure history. Emphasis was placed on the difficulties inherent in measuring the exposure of small children. Attendees were divided into three working groups, addressing the following questions, respectively: How can historical exposure best be assessed; what should be measured outdoors; and what should be measured indoors? Consensus on a single protocol was not found to be possible, given the state of knowledge about EMF exposure and the pathophysiology of childhood leukemia. However, the discussion produced a comprehensive analysis of the issues involved in addressing the crucial questions of who and what should be measured, and when, where and how these measurements should take place. In particular, discussion focused on: personal monitoring versus area measurements; exposure metrics; relevant time periods over the subjects life for measurement; location and duration of measurements; and protocol development considerations. Attendees expressed strong interest in another, similar workshop sometime in the future. 1 tab.

41748 (PB–90-217555/XAB) **Developmental effects of pulsed magnetic fields on animal embryos.** Berman, E. Environmental Protection Agency, Research Triangle Park, NC (USA). Health Effects Research Lab. ©1990. 7p. (EPA–600/J-90/039). Available from NTIS, PC A02/MF A01.

Pub. in Reproductive Toxicology, Vol. 4, 45-49(Mar 1990).

The paper contains a critical review of the available literature on the subject of the effects of developing animals from exposure to pulsed magnetic fields (PMF). The workshop at which the presentation was originally made discussed the reproductive effects in women from the use of video display terminals. Apparently, exposure of embryonic animal models (chick embryo, fish embryo, rat and mouse embryos) in PMF may result in statistically significant increases in detrimental effects. The appearance of the effect (usually, increased abnormality rates) is not clearly relatable to pulse frequency, pulse shape, or field intensity.

41749 (PB–90-870098/XAB) **Biological effects of microwave radiation. February 1984-April 1990 (A Bibliography from the INSPEC: Information Services for the Physics and Engineering Communities data base). Report for February 1984-April 1990.** National Technical Information Service, Springfield, VA (USA). May 1990. 205p. Available from NTISPC N01/MF N01.

Supersedes PB–89-855084.

This bibliography contains citations concerning the short and long term effects of microwave radiation. The physiological effects of thermal stress are considered. Experimental data, including methodology and evaluation, are also presented. (This updated bibliography contains 358 citations, 120 of which are new entries to the previous edition.)

41750 Reproduction, growth, and development of rats during chronic exposure to multiple field strengths of 60-Hz electric fields. Rommereim, D.N. (Battelle, Pacific Northwest Laboratories, Richland, WA (USA)); Rommereim, R.L.; Sikov, M.R.; Buschbom, R.L.; Anderson, L.E. *Fundamental and Applied Toxicology (USA)*, 14(3): 608-621 (Apr 1990).

A study with multiple exposure groups and large group sizes was performed to establish whether exposure to 60-Hz electric fields would result in reproductive and developmental toxicity. A response model was developed from previous results and tested in groups of rats exposed to electric fields at various field strengths. Female rats were mated, and sperm-positive animals randomly distributed among four groups: sham-exposed or exposed to 10, 65, or 130 kV/m, 60-Hz vertical electric fields. Animals were exposed for 19 hr/day throughout the experiment. During gestation, exposure to the higher field strengths resulted in slightly depressed weight gains of dams. Offspring were born in the field and remained with their dams through the suckling period. Numbers of pups per litter and pup mortality did not differ among the exposure groups. Dams exposed at 65 kV/m lost slightly more weight through the lactation period than the control group. Male pups exposed to higher field strengths gained slightly less weight from 4 to 21 days of age than did sham-exposed animals. At weaning, two F1 females per litter (randomly selected) continued on the same exposure regimen were mated at 11 weeks of age to unexposed males, and euthanized at 20 days of gestation. Uterine contents were evaluated, and all live fetuses were weighed and examined for external, visceral, and skeletal malformations. Fertility and gestational weight gain of F1 females were not affected by exposure, nor was prenatal viability or fetal body weight. No significant increase in the incidence of litters with malformations was observed. Although no developmental toxicity was detected, exposures produced physical changes in the dams, evidenced as a rust-colored deposit on the muzzle and ears (chromodacryorrhea) that increased in incidence and severity at 65 and 130 kV/m.

57 HEALTH AND SAFETY

Refer also to citation(s) 40869

41751 (DOE–76-45/37) **Time/loss analysis.** Horman, R.L. EG and G Idaho, Inc., Idaho Falls, ID (USA). System Safety Development Center. Feb 1987. 29p. Sponsored by U.S. DOE Environment Health & Safety. DOE Contract AC07-76ID01570. (SSDC–37). Order Number DE90014195. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Time/loss analysis (T/LA) is a technique originally developed within the National Transportation Safety Board (NTSB), to evaluate response performance in dangerous goods transportation emergencies. It analyzes the effect of intervenors in an accident situation – intervenors being people or objects which change the natural course of an accident sequence. Through experience, it has been found that intervenors may have a positive effect, no effect, or even a negative effect on the outcome of an accident. T/LA becomes an important tool in looking at the amelioration process in an accident sequence (amelioration being those things done following an accident to reduce its consequences and to prevent a second accident from occurring). T/LA is valuable both as an accident investigation tool and also as a preaccident systems analysis tool to assure that the proper intervenors are in place in case an accident occurs. 4 refs., 12 figs.

58 GEOSCIENCES

Refer also to citation(s) 40369, 40370, 40408, 40416, 40418, 40427, 40429, 40430, 40431, 40432, 40568, 40571, 41193, 41246, 41255, 41582, 41586

41752 (BNL–44637) **Shelf Edge Exchange Processes–II: SEEP2-10, R/V ENDEAVOR cruise 195: Hydrographic data report.** Behrens, W.J.; Wilson, C.; Flagg, C.N.; Wallace, D.W.R.; Wilke, R.J.; Wyman, K.D. Brookhaven National Lab., Upton, NY (USA). Apr 1990. 431p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76CH00016. Order Number DE90014315. Available from NTIS, PC A19/MF A01 - OSTI; GPO Dep.

The Shelf Edge Exchange Processes (SEEP) program sponsored by the United States Department of Energy is a multi-institutional effort designed to investigate the flux of suspended material from the continental shelf to the waters of the upper slope, and then possibly into the slope sediments. This project consisted of a series of ten cruises, a mooring array, and a series of overflights by NASA aircraft. Hydrographic data were collected on eight of the cruises, six of which were primarily mooring deployment or recovery cruises. The cruises were consecutively designated SEEP2-01 to SEEP2-10. Two cruises (SEEP2-04 and SEEP2-07) were dedicated to investigating benthic processes and hydrographic data were not collected. The R/V ENDEAVOR cruise 193, SEEP2-09, took place from 2–12 May 1989 and recovered ten mornings along two cross-shelf lines across the outer continental shelf. During this cruise 77 CTD casts were made measuring pressure, temperature, conductivity, dissolved oxygen, fluorescence and light transmission. Discrete samples were taken in rosette-mounted Niskin bottles and analyzed for concentration of nutrients, chlorophyll a, dissolved oxygen, and particulate organic carbon and nitrogen. 14 refs., 9 figs., 3 tabs.

41753 (EGG-M–89243) **Petrophysical characteristics of basalt in the vadose zone, Idaho National Engineering Laboratory, Eastern Snake River Plain, Idaho.** Knutson, C.F.; Harrison, W.E.; Smith, R.P. EG and G Idaho, Inc., Idaho Falls, ID (USA). [1989]. 45p. Sponsored by U.S. DOE Radioactive Waste Management. DOE Contract AC07-76ID01570. (CONF-891057–5: 3. international symposium on borehole geophysics, Las Vegas, NV (USA), 2-5 Oct 1989). Order Number DE90010940. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

We have used a core characterization system to measure bulk densities, porosities, and permeabilities of basalt lavas from the vadose zone at the Idaho National Engineering Laboratory (INEL). At the INEL, basalt lava flows with intercalated alluvial, aeolian, and lacustrine sediments extend to depths of one kilometer or more. Individual lava flows are generally less than 15 meters thick and commonly have vesicular tops and bottoms with massive basalt in their interiors. Petrophysical characterization is essential to an understanding of fluid movement in the vadose zone and in the saturated zone. Many hundreds of closely spaced permeability/porosity/bulk density measurements have defined the variability of these parameters within and between individual basalt flows. Based on geological logging and porosity/permeability measurements made on many hundred feet of core, we feel that a rather sophisticated and rigorous logging program is necessary to characterize these complex and highly variable basaltic flow units. This paper endeavors to provide a petrophysical/geological conceptual model of the Snake River Plain basalts from the vadose zone under the Radioactive Waste Management Complex area at the INEL. We hope that this model will aid in subsequent geotechnical logging in this portion of the Eastern Snake River Plain. 8 refs., 14 figs., 2 tabs.

41754 (UCRL-JC–103661) **Biot's slow wave in Massillon and Berea sandstones.** Bonner, B.P. (Lawrence Livermore National Lab., CA (USA)); Berryman, J.G.; Nagy, P.B.; Xue, Qiang; Adler, L. Lawrence Livermore National Lab., CA (USA). May 1990. 7p. Sponsored by U.S. DOE Energy Research. DOE Contract W-7405-ENG-48 ;FG02-87ER13749. (CONF-900907–1: Annual meeting of the Society of Exploration Geophysicists, San Francisco, CA (USA), 23-27 Sep 1990). Order Number DE90011229. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Biot,s proposed a comprehensive theory that has explained many of the important features of wave propagation in fluid-saturated porous media. One striking feature of the theory is the prediction of a slow compressional wave with a speed lower than that of either component. Since the slow mode involves a coupled motion of fluid and solid, it's speed and attenuation depend on the morphology of the pore space, which also determines fluid transport properties such as formation permeability. Mode conversion from fast to slow waves at interfaces should contribute a source of strong wave attenuation as the slow wave propagates. In site of the revival of interest in the predicted mode, no unambiguous examples of slow wave propagation in natural rocks for viscous fluids have been reported because of strong attenuation and interference from the ordinary fast compressional and shear waves. We describe here a new experimental technique using air coupled ultrasonic waves and air saturation that allows unambiguous observations of slow waves in both synthetic and natural porous materials. This method provides a direct link between fluid transport and wave propagation properties for porous rocks. 5 refs., 2 figs.

41755 **What drives glacial cycles?.** Broecker, W.S.; Denton, G.H. *Scientific American (USA),* 262(1): 49-56 (Jan 1990).

The Milankovitch theory advocates that the glacial cycles have three components: the tilt of the earth's spin axis; the shape of the earth's orbit; and the interaction between the tilt and the eccentricity effects. These three factors work together to vary the amount of sunshine reaching the high northern latitudes in summer and allow the great ice sheets to grow during intervals of cool summers and mild winters. Evidence is presented which indicates that the circulation pattern of the Atlantic ocean was shifted dramatically about 14,000 years ago, at the same time that glaciers in both hemispheres started to retreat. The authors believe that massive reorganizations of the ocean-atmosphere system are the key events that link cyclic changes in the earth's orbit to the advance and retreat of ice sheet.

41756 **The evolution of the earth's magnetic field.** Bloxham, J.; Gubbins, D. *Scientific American (USA),* 261(6): 68-75 (Dec 1989).

The origin of the magnetic field has fascinated more than a dozen generations of physicists. Molten iron in the outer core, driven by convection and influenced by the earth's rotation, acts as a dynamo that generates the field. Now historical records of magnetic-field changes yield new insights into the process and into how the field may behave in the future. Investigations have inferred the general characteristics of the fluid flow inside the core. Four patches on the core surface that contribute most strongly to the dipole field are thought to be the tops and bottoms of two columns of liquid. The authors believe that fluid spirals down through the

two columns and so creates a dynamo process that concentrates flux within the columns.

41757 Volcanism at rifts. White, R.S.; McKenzie, D.P. *Scientific American (USA),* 261(1): 62-71 (Jul 1989).

The earth's outer shell rifts continuously, stretching and splitting both on the ocean's floor and on continents. Every 30 million years or so the rifting becomes cataclysmic, releasing continent-size floods of magma. This paper explains that the same mechanism is at work in both cases, the difference being in the slightly hotter temperature of the parent mantle for spectacular volcanic outbursts. Two kinds of evidence are described: quantitative descriptions of rock melting and a wide range of observations made on the rifted edges of continents and in the oceans that have opened between them.

41758 Hidden earthquakes. Stein, R.S.; Yeats, R.S. *Scientific American (USA),* 260(6): 48-57 (Jun 1989).

Seismologists generally look for earthquakes to happen along visible fault lines, e.g., the San Andreas fault. The authors maintain that another source of dangerous quakes has been overlooked: the release of stress along a fault that is hidden under a fold in the earth's crust. The paper describes the differences between an earthquake which occurs on a visible fault and one which occurs under an anticline and warns that Los Angeles greatest earthquake threat may come from a small quake originating under downtown Los Angeles, rather than a larger earthquake which occurs 50 miles away at the San Andreas fault.

41759 Modeling the geochemical carbon cycle. Berner, R.A.; Lasaga, A.C. *Scientific American (USA),* 260(3): 74-81 (Mar 1989).

The authors have modeled the slow, long-term cycle in which geochemical processes transfer carbon among land, sea, and atmosphere. The model suggests that the earth may have been warmed in the past when buildups of atmospheric carbon dioxide enhanced the greenhouse effect. The model predicts that the slow natural fluctuations of atmospheric carbon dioxide may rival or even exceed the much faster changes that arise from human activities or from the biological carbon cycle. The main purpose in modeling the geochemical carbon cycle is to expose how little is known about the rates of important global processes and how seemingly unrelated processes (such as tectonism and climate) are linked.

41760 Deep earthquakes. Frohlich, C. *Scientific American (USA),* 260(1): 48-55 (Jan 1989).

Earthquakes are often recorded at depths as great as 650 kilometers or more. These deep events mark regions where plates of the earth's surface are consumed in the mantle. But the earthquakes themselves present a conundrum: the high pressures and temperatures at such depths should keep rock from fracturing suddenly and generating a tremor. This paper reviews the research on this problem. Almost all deep earthquakes conform to the pattern described by Wadati, namely, they generally occur at the edge of a deep ocean and define an inclined zone extending from near the surface to a depth of 600 kilometers of more, known as the Wadati-Benioff zone. Several scenarios are described that were proposed to explain the fracturing and slipping of rocks at this depth.

41761 Measuring crustal deformation in the American West. Jordan, T.H.; Minster, J.B. *Scientific American (USA),* 259(2): 48-58 (Aug 1988).

The crust of the western US is deforming as the Pacific and North American plates slide past each other along the San Andreas Fault, the Great Basin is spreading apart, and mountains are being thrust up along the California coast. Monitoring of these processes over the years has resulted in the San Andreas discrepancy, the mismatch between the rate and direction of horizontal slippage along the fault and the relative motion of the Pacific and North American plates.This process will soon be measured directly using the new developed technique of space geodesy, which uses radio waves from quasars or satellites to measure between fixed stations with an accuracy of a few centimeters.

41762 The supercontinent cycle. Nance, R.D.; Worsley, T.R.; Moody, J.B. *Scientific American (USA),* 259(1): 72-79 (Jul 1988).

This paper discusses a new theory of plate tectonics which proposes that Pangaea was only the most recent in a series of supercontinents that have been breaking up and reassembling every 500 million years or so. The cycle, driven by heat percolating up from the mantle, splits continents and drives interrelated processes that shape the earth's geology and climate and play a role in biological evolution. The framework of the supercontinent theory makes it possible to understand the timing of changes in sea level that have taken place in the past 570 million years, and also helps to explain periods of intense mountain building, episodes of glaciation, and changes in the nature of life on the earth.

64 PHYSICS I

41763 (JINR–1-34-89) **JINR rapid communications: Collection.** Joint Inst. for Nuclear Research, Dubna (USSR). 1989. 86p. (In Russian). Order Number DE90706109. Available from NTIS (US Sales Only), PC A05/MF A01; OSTI; INIS.

Individual papers in this collection are indexed separately.

6401 Astrophysics and Cosmology

Refer also to citation(s) 40829, 41827, 41876, 41939, 41971, 42109, 42136, 42139

41764 (ESA-SP–302, pp. 83-88) **Physico-chemical properties of formaldehyde-ice-dust mixtures.** Boice, D.C.; Naegeli, D.W.; Huebner, W.F. European Space Agency, 75 - Paris (France). Dec 1989. (ETN–90-96299;CONF-8910423–: Conference on physics and mechanics of cometary materials, Muenster (Germany, F.R.), 9 Oct 1989). In *Physics and Mechanics of Cometary Materials.* Available from NTIS, PC A10/MF A02; ESA Publications Div., ESTEC, Noordwijk, Netherlands, 60 Dutch guilders.

One of the spectacular surprises of the recent spacecraft encounters with the comet Halley was the discovery of complex organic molecules associated with dust grains in the coma, namely the CHON particles. Formaldehyde oligomers were identified as a constituent of the complex mixture that constitutes the organic component of the dust. These oligomers when end-capped with water are observed in the laboratory to be stable in the gas phase up to 5 monomeric units in length and at temperatures characteristic of dust grains in the coma and higher. An overview of further experiments concerning the physico-chemical nature of formaldehyde-ice-dust mixtures relevant to the comet nucleus and dust is given.

41765 (FRCEA-TH–266) **Type II supernovae modelisation: neutrinos transport simulation.** Mellor, P. CEA Centre d'Etudes de Bruyeres-le-Chatel, 91 (France); Paris-7 Univ., 75 (France). Oct 1988. 214p. (In French). Order Number DE90508412. Available from NTIS (US Sales Only), PC A10/MF A01.

A modelisation of neutrino transport in type II supernovae is presented. The first part is a description of hydrodynamics and radiative processes responsible of supernovae explosions. Macroscopic aspects of these are displayed in part two. Neutrino transport theory and usual numerical methods are also developed. A new technic of coherent scattering of neutrinos on nuclei or free nucleons is proposed in the frame work of the Lorentz bifluid approximation. This method deals with all numerical artifices (flux limiting schemes, closure relationship of Eddington moments) and allows a complete and consistent determination of the time-dependent neutrino distribution function for any value of the opacity, gradient of opacity and for all (relativistic) velocity fields of the diffusive medium. Part three is dedicated to microscopic phenomena (electronic capture, chimical composition, etc) which rule neutrinos emission-absorption mechanisms. The numerical treatments of those are presented, and some applications are useful for their parametrization. Finally, an extension of the method to inelastic scattering on light particules (electrons) is described in view to study neutrinos thermalization mechanism.

41766 (IC–90/59) **A tentative mathematical description of oscillating peak model of multi-ring basin.** Chen Daohan (International Centre for Theoretical Physics, Trieste (Italy)); Yue

Zengyuan; Zhang Bin. International Centre for Theoretical Physics, Trieste (Italy). Mar 1990. 8p. Order Number DE90632060. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

The oscillating peak model of basin and crater formation proposed by Murray is analysed mathematically. The results could be compared with some basins and would help to confirm the basic ideas of this model. (author). 6 refs, 1 tab.

41767 (IC–90/60) **On the tsunami model of the origin of multi-ring basins.** Yue Zengyuan (Beijing Univ., BJ (China). Dept. of Geophysics); Zhang Bin; Chen Daohan. International Centre for Theoretical Physics, Trieste (Italy). Mar 1990. 8p. Order Number DE90632061. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

By use of the theory of shallow water waves generated by an impulsive pressure, the tsunami theory of the origin of multi-ring basins is rediscussed and an approximate formula used for calculating the ring location is derived. From the computed ring spacing of three multi-ring basins on the moon (Orientale, Moscoviense and Serenitatis South), it is shown that the tsunami model can only be applied to the area within the IV ring which signifies the rim of the excavated basin and the end of the fluidized region. In the frame of the tsunami model, no explanation for ring spacing is equally plausible for exterior rings as well as interior ones. (author). 14 refs, 1 tab.

41768 (INS–804) **A new vector-tensor theory and higher-dimensional cosmology.** Yoshida, K. (Tokyo Metropolitan Univ. (Japan). Dept. of Physics); Shiraishi, K. Tokyo Univ., Tanashi (Japan). Inst. for Nuclear Study. Jan 1990. 15p. Order Number DE90507990. Available from NTIS (US Sales Only), PC A03/MF A01.

A new vector-tensor model of classical gravity, which contains coupling between the field strength of the vector field and the curvature tensors in six dimensions, is proposed. Cosmological solutions of the scale factors in this model with the compactified space are obtained. The generalization of the model is also considered. (author).

41769 (KFKI–1989-64/B) **Phenomenology of cosmic phase transitions.** Kaempfer, B. (Zentralinstitut fuer Kernforschung, Rossendorf (German Democratic Republic)); Lukacs, B.; Paal, G. Hungarian Academy of Sciences, Budapest (Hungary). Central Research Inst. for Physics. Nov 1989. 67p. Order Number DE90632119. Available from NTIS (US Sales Only), PC A04/MF A01; OSTI; INIS.

The evolution of the cosmic matter from Planck temperature to the atomic combination temperature is considered from a phenomenological point of view. Particular emphasis is devoted to the sequence of cosmic phase transitions. The inflationary era at the temperature of the order of the grand unification energy scale and the quantum chromodynamic confinement transition are dealt with in detail. (author) 131 refs.; 26 figs.

41770 (KFKI–1990-01/C) **Particle acceleration in the plasma fields near comet Halley.** Somogyi, A.J. (Hungarian Academy of Sciences, Budapest (Hungary). Central Research Inst. for Physics); Erdoes, G.; Axford, W.I.; Ip, W.-H.; Shapiro, V.D.; Shevchenko, V.I. Hungarian Academy of Sciences, Budapest (Hungary). Central Research Inst. for Physics. Jan 1990. 41p. Order Number DE90632062. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Spacecraft VEGA-1 approached Halley comet to distances less than 10 million km in March 1986. It was equipped with devices capable to detect and measure the energies of charged particles (higher than 50 keV). After a survey of acceleration mechanisms the properties of the 50-800 keV charged particle fluxes observed in various regions around Halley comet are reported. In particular, the regions outside the cometary bow shock, the region between the bow shock and the cometopause, and inside the latter, especially in the magnetic pile-up region are considered. Possible mechanisms responsible for the accelerations of the particle fluxes described are discussed. (author) 73 refs.; 7 figs.; 3 tabs.

41771 (LBL–29081) **Rotating neutron stars and the equation of state of dense matter.** Weber, F. (Lawrence Berkeley Lab., CA (USA)); Glendenning, N.K.; Weigel, M.K. Lawrence Berkeley Lab., CA (USA). May 1990. 16p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00098. (CONF-9005233–2: International conference on medium- and high-energy physics, Taipei (Taiwan), 14-18 May 1990). Order Number DE90014185. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

We investigate the properties of non-rotating as well as rotating neutron stars in the framework of Einstein's theory of general relativity. The nuclear equation of state of neutron star matter (electrically charge neutral many-baryon/lepton system) is calculated for the relativistic Hartree- and Hartree-Fock approximations. The influence of two-particle correlations on the equation of state is taken into account, too. An important result is that the limiting rotational frequency of a neutron star is set by instability modes caused by gravitational radiation reaction, which set in well below the Kerplerian frequency. 20 refs., 7 figs., 3 tabs.

41772 (N–90-18957) **Annihilation in Gases and Galaxies.** Drachman, R.J. National Aeronautics and Space Administration, Greenbelt, MD (USA). Goddard Space Flight Center. Jan 1990. 271p. (NASA-CP–3058;REPT–90B00019;NAS–1.55:3058;CONF-8907143–: Workshop on annihilation in gases and galaxies, Greenbelt, MD (USA), 19-21 Jul 1989). Available from NTIS, PC A12/MF A02.

This publication contains most of the papers, both invited and contributed, that were presented at the Workshop of Annihilation in Gases and Galaxies. This was the fifth in a biennial series associated with the International Conference on the Physics of Electronic and Atomic Collisions. Subjects covered included the scattering and annihilation of positrons and positronium atoms in various media, including those of astrophysical interest. In addition, the topics of antimatter and dark matter were covered.

41773 (N–90-19940) **Relativistic Gravitational Experiments in Space.** Hellings, R.W. National Aeronautics and Space Administration, Washington, DC (USA). Aug 1989. 242p. (NASA-CP–3046;NAS–1.55:3046;CONF-8806193–: Workshop on relativistic gravitation experiments in space, Annapolis, MD (USA), 28-30 Jun 1988). Available from NTIS, PC A11/MF A02.

The results are summarized of a workshop on future gravitational physics space missions. The purpose of the workshop was to define generic technological requirements for such missions. NASA will use the results to direct its program of advanced technology development.

41774 (N–90-20030) **MAX 1991. The active sun: A plan for pursuing the study of the active sun at the time of the next maximum in solar activity, January 1985.** Acton, L. Air Force Geophysics Lab., Hanscom AFB, MA (USA). Aug 1989. 28p. (NASA-CR–186125;NAS–1.26:186125;AD–A211700;GL-TR–89-0218). Available from NTIS, PC A03/MF A01.

The results of the discusions of a working group for the definition of a program for the forthcoming crest of solar activity, 1990 to 1993 are presented. The MAX '91 program described are intended to achieve important scientific goals within the context of the natural solar variability. The heart of the MAX '91 program is a series of campaigns oriented towards specific scientific problems, and taking place in the solar maximum period 1990 to 1993. These campaigns will take advantage of the load-carrying capability of the Space Shuttle to fly instruments with observational capabilities very different from those of the Solar Maximum Mission. Various combinations of instruments appropriate to the specific scientific problem of a given campaign would be flown on a Shuttle sortie mission.

41775 (N–90-20914) **The inter-outburst behavior of cataclysmic variables.** Szkody, P.; Mattei, J.A.; Waagen, E.O.; Stablein, C. Washington Univ., Seattle, WA (USA). 1990. 27p. (NASA-CR–186374;NAS–1.26:186374). Available from NTIS, PC A03/MF A01.

Existing International Ultraviolet Explorer (IUE) and American Association of Variable Star Observers (AAVSO) archive data was used to accomplish a large scale study of what happens to the ultraviolet flux of accretion disk systems during the quiescent intervals between outbursts and how it relates to the preceding outburst characteristics of amplitude and width. The data sample involved multiple IUE observations for 16 dwarf novae and 8 novae along

with existing optical coverage. Results indicate that most systems show correlated ultraviolet (UV) flux behavior with interoutburst phase, with 60 percent of the dwarf novae and 50 percent of the novae having decreasing flux trends while 33 percent of the dwarf novae and 38 percent of the novae show rising UV flux during the quiescent interval. All of the dwarf novae with decreasing UV fluxes at 1475A have orbital periods longer than 4.4 hours, while all (except BV Cen) with flat or rising fluxes at 1475A have orbital periods less than two hours. There are not widespread correlations of the UV fluxes with the amplitude of the preceding outburst and no correlations with the width of the outburst. From a small sample (7) that have relatively large quiescent V magnitude changes between the IUE observations, most show a strong correlation between the UV and optical continuum. Interpretation of the results is complicated by not being able to determine how much the white dwarf contributes to the ultraviolet flux. However, it is now evident that noticeable changes are occurring in the hot zones in accreting systems long after the outburst, and not only for systems that are dominated by the white dwarf. Whether these differences are due to different outburst mechanisms or to changes on white dwarfs which provide varying contributions to the UV flux remains to be determined.

41776 (N–90-20918) **Studies of the evolution of the x ray emission of clusters of galaxies. Final technical report, 1 July 1988-31 December 1989.** Henry, J.P. Hawaii Univ., Honolulu, HI (USA). Apr 1990. 21p. (NASA-CR–186471;NAS–1.26:186471). Available from NTIS, PC A03/MF A01.

The x ray luminosity function of clusters of galaxies was determined at different cosmic epoches using data from the Einstein Observatory Extended Medium Survey. The sample consisted of 67 x ray selected clusters that were grouped into three redshift shells. Evolution was detected in the x ray properties of clusters. The present volume density of high luminosity clusters was found to be greater than it was in the past. This result is the first convincing evidence for evolution in the x ray properties of clusters. Investigations into the constraints provided by these data on various Cold Dark Matter models are underway.

41777 (N–90-21711) **VLA observations of the coronal plasma.** Lang, K.R. Tufts Univ., Medford, MA (USA). 1989. 11p. (NASA-CR–186540;NAS–1.26:186540;CONF-8912104–: 142. IAU symposium on basic plasma processes on the sun, Bangalore (India), 1-5 Dec 1989). Available from NTIS, PC A03/MF A01.

VLA observations at 20 cm wavelength specify the brightness temperature and magnetic structure of plasma constrained within coronal loops in solar active regions. Comparisons with simultaneous SMM observations at soft x ray wavelengths lead to measurements of physical parameters like electron density, electron temperature and magnetic field strength. Such comparisons also indicate coronal loops can be detected at either radio or x ray wavelengths while remaining invisible in the other spectral domain, and that the dominant radiation mechanisms can be thermal bremsstrahlung or thermal gyroresonance radiation. VLA observations at the longer 90 cm wavelength reveal the thermal emission of a hot transition sheath enveloping a cooler, underlying H alpha filament seen in absorption. The 20 cm VLA observations indicate that the precursor, impulsive and post-flare components of solar flares originate in spatially separated and resolved sources. The 90 cm VLA data indicate that time-correlated radio bursts can occur in active regions on opposite sides of the solar equator. These regions are apparently linked by large scale, trans-equatorial magnetic loops at least 2.6 x 10(exp 5) km (or 6 feet) long; these loops act as magnetic conduits for relativistic electrons moving at one-third the velocity of light.

41778 (N–90-21719) **Flare stars at radio wavelengths.** Lang, K.R. Tufts Univ., Medford, MA (USA). 1989. 14p. (NASA-CR–186539;NAS–1.26:186539;CONF-8910431–: 137. IAU symposium on flare stars, Armenia (USSR), 23 Oct 1989). Available from NTIS, PC A03/MF A01.

The radio emission from dMe flare stars is discussed using Very Large Array and Arecibo observations as examples. Active flare stars emit weak, unpolarized, quiescent radio radiation that may be always present. Although thermal bremsstrahlung and/or thermal gyroresonance radiation account for the slowly-varying, quiescent radio radiation of solar active regions, these processes cannot account for the long-wavelength quiescent radiation observed from nearby dMe flare stars. It has been attributed to nonthermal gyrosynchrotron radiation, but some as yet unexplained mechanism must be continually producing the energetic electrons. Long duration, narrow-band radiation is also emitted from some nearby dMe stars at 20 cm wavelength. Such radiation may be attributed to coherent plasma radiation or to coherent electron-cyclotron masers. Impulsive stellar flares exhibit rapid variations that require radio sources that are smaller than the star in size, and high brightness temperatures greater than 10(exp 15) K that are also explained by coherent radiation processes. Quasi-periodic temporal fluctuations suggest pulsations during some radio flares. Evidence for frequency structure and positive or negative frequency drifts during radio flares from dMe stars is also presented.

41779 (PB–90-868761/XAB) **Blackbody radiation. April 1971-April 1990 (A Bibliography from the Searchable Physics Information Notices data base). Report for April 1971-April 1990.** National Technical Information Service, Springfield, VA (USA). May 1990. 141p. Available from NTISPC N01/MF N01.

Supersedes PB–85-865095.

This bibliography contains citations concerning the detection, measurement, analysis, and interpretation of blackbody radiation from various sources ranging from black holes to steller objects to blackbody cavities. Theoretical and experimental considerations and some attention to simulation are included. (This updated bibliography contains 305 citations, 103 of which are new entries to the previous edition.)

41780 **Study of Cygnus X-3 at ultrahigh energies during the 1989 radio outbursts.** Alexandreas, D.E.; Allen, R.C.; Berley, D.; Biller, S.D.; Burman, R.L.; Cady, R.; Chang, C.Y.; Dingus, B.L.; Dion, G.M.; Ellsworth, R.W. *Physical Review Letters (USA)*, 64(25): 2973-2975 (18 Jun 1990).

A unique feature of Cygnus X-3 is that occasionally it has large radio outbursts that begin very abruptly and last for several days. Several experiments in the past have claimed to observe signals above 1 TeV correlated with these radio bursts; the most recent bursts occurred in June and July 1989. No significant signal was observed by the CYGNUS experiment over time scales longer than a day during this time; a 90%-confidence-level limit of 3.0×10^{-13} cm^{-2} s^{-1} is placed on the flux above 50 TeV during the period from 15 May to 31 July 1989.

41781 **Supersymmetric dark matter above the *W* mass.** Griest, K. (Center for Particle Astrophysics, University of California, Berkeley, CA (USA)); Kamionkowski, M.; Turner, M.S. *Physical Review, D (Particles Fields) (USA)*, 41(12): 3565-3582 (15 Jun 1990).

In this paper we study the cosmological consequences of the minimal supersymmetric extension of the standard model in the case that the neutralino is heavier than the *W*. We calculate the cross section for annihilation of heavy neutralinos into final states containing gauge and Higgs bosons ($\tilde{\chi}\ \tilde{\chi}\rightarrow WW,ZZ,HH,HW,HZ$) and combine these results with those previously obtained for annihilation into fermions to find the relic cosmological abundance for the most general neutralino. The new channels are particularly important for Higgsino-like and mixed-state neutralinos, but are subdominant (to the fermion-antifermion annihilation channels) in the case that the neutralino is mostly a gaugino. The effect of the top-quark mass is also considered. Using these cross sections and the cosmological constraint $\Omega_{\tilde{\chi}}h^2\lesssim1$ we map the entire range of cosmologically acceptable supersymmetric parameter space and find a very general bound on the neutralino mass. For a top-quark mass of less than 180 GeV, neutralinos heavier than 3200 GeV are cosmologically inconsistent, and if the top-quark mass is less than 120 GeV, the bound is lowered to 2600 GeV. We find that a "heavy" neutralino ($m_{\tilde{\chi}}>m_W$) that contributes $\Omega_{\tilde{\chi}}\sim1$ arises for a very wide range of model parameters and makes, therefore, a very natural and attractive dark-matter candidate.

41782 **Quantum effects of domain-wall formation in the early Universe.** Anderson, P.R. (Physics Department, Montana State University, Bozeman, Montana 59717 (USA)); Hiscock, W.A.; Holman, R. *Physical Review, D (Particles Fields) (USA)*, 41(12): 3604-3611 (15 Jun 1990). DOE Contract AC02-76ER03066.

We consider the formation of domain walls in the early Universe. Our models consist of spacetimes which are initially either Minkowski or de Sitter space and which evolve into the type-I or -II domain-wall spacetimes of Ipser and Sikivie. The geometrical matching between these spacetimes is done explicitly and the structure of the resulting spacetime is studied. Finally, we consider quantum field theory in these spacetimes. We study the effects of particle production and vacuum polarization which result from the formation and existence of type-I domain walls by computing the energy density of a quantized scalar field. We find that these effects are important only for walls with Planckian surface tension such as those that occur in some superstring models.

41783 **Thermal properties of open-superstring models.** Clavelli, L. (Department of Physics and Astronomy, University of Alabama, Tuscaloosa, Alabama 35487 (USA)); Elmfors, P. *Physical Review, D (Particles Fields) (USA)*, 41(12): 3768-3772 (15 Jun 1990). DOE Contract FG05-84ER40141.

We investigate the one-loop mass shifts at finite temperature of the ground-state scalar mesons in a sequence of lower-dimensional open-superstring theories. Qualitative differences are seen in the behavior of the mass shifts for different space-time dimensions.

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Refer also to citation(s) 40829

41784 (AD-A-219981/8/XAB) **Observations of large-amplitude, whistler-mode wave ducts in the outer plasmasphere. Technical report.** Koons, H.C. Aerospace Corp., El Segundo, CA (USA). Space Sciences Lab. 12 Feb 1990. 23p. (TR-0089(4940-06)-5). Available from NTIS, PC A03/MF A01.

Original contains color plates: All DTIC reproductions will be in black and white.

Strong enhancements of whistler-mode hiss emissions have been observed to correlate with plasma density enhancements in the outer plasmasphere between L = 4 and L = 6 (L = McIlwain's parameter). This indicates that these density enhancements are acting as whistler-mode wave ducts. The wave and density observations were made simultaneously by The Aerospace Corporation swept frequency receiver (SFR) aboard the Active Magnetospheric Particle Tracer Explorer (AMPTE) ion release module (IRM) spacecraft. The plasma density is determined from a narrowband line near the plasma frequency. The hiss emissions generally occur below 2 kHz. The ducts consist of density enhancements of more than 40%. Density gradients on the sides of ducts range from 0.10 to 0.24 electrons per cubic centimeter per kilometer. The half width of each duct is typically 250 km. The wave intensity maximizes about 15 km from the center of the duct toward the outside, i.e., the side with a negative density gradient with increasing distance. The wave intensity near the center of a duct is an order of magnitude higher than the wave intensity at the density minimum between ducts.

41785 (AD-A-220004/6/XAB) **Analytic/empirical model of the middle- and low-latitude ionosphere. Interim scientific report.** Forbes, J.M.; Anderson, D.N.; Codrescu, M.; Batista, P.P. Air Force Geophysics Lab., Hanscom AFB, MA (USA). 31 Mar 1989. 54p. (GL-TR-89-0096). Available from NTIS, PC A04/MF A01.

An improved analytic/empirical model of F-layer plasma density is developed by modifying the Chiu (1975) model so as to: (a) better approximate middle latitude F-layer peak heights (hmF2's) as derived from ionosonde data, and (b) better model features such as the post-sunset rise in the F-layer peak height, and the equatorial anomaly maxima in plasma density near + or - 15 geomagnetic latitude. The latter is accomplished by applying analytic low-latitude correction as derived from differences between the Chiu model and the SLIM model of Anderson et al. Results of a numerical model are also presented that demonstrate the importance of these low-latitude plasma structures tot he neutral dynamics of the thermosphere.

41786 (AD-A-220099/6/XAB) **Radar detection during scintillation. Technical report.** Knepp, D.L.; Reinking, J.T. Mission Research Corp., Pacific Grove, CA (USA). Apr 1990. 66p. Available from NTIS, PC A04/MF A01.

Electromagnetic signals that propagate through a disturbed region of the ionosphere can experience scattering which can cause fluctuations in the received amplitude, phase, and angle-of-arrival. This report considers the performance of a radar that must operate through a disturbed propagation environment such as might occur during strong equatorial scintillation, during a barium release experiment or after a high altitude nuclear detonation. The severity of the channel disturbance is taken to range from weak scattering where the signal quadrature components are uncorrelated Gaussian variates. The detection performance of noncoherent combining is compared to that of double threshold (M out of N) combining under various levels of scintillation disturbance. Results are given for detection sensitivity as a function of the scintillation index and the ratio of the radar hopping bandwidth to the channel bandwidth. It is shown that both types of combining can provide mitigation of fading, and that noncoherent combining generally enjoys an advantage in detection sensitivity of about 2 dB. This work serves as a quantitative guideline to the advantages and disadvantages of certain types of detection strategies during scintillation and is, therefore, useful in the radar design process. However, a detailed simulation of the radar detection algorithms is necessary to evaluate a radar design strategy to predict performance under scintillation conditions.

41787 (AD-A-220105/1/XAB) **Ionospheric equivalent slab thickness and its modeling applications. Technical report.** Fox, M.; Mendillo, M. Boston Univ., MA (USA). Center for Space Physics. Nov 1989. 46p. (SCIENTIFIC-2). Available from NTIS, PC A03/MF A01.

A database of equivalent slab thickness observations covering nearly two complete solar cycles has been obtained at a mid-latitude site (Hamilton, MA). This database has been studied for correlations between the various parameters as well as for dependencies on observable quantities. The mean variations of tau are described both qualitatively, in terms of changes to profile shapes, and quantitatively, in terms of a simple numerical model. A preliminary investigation of the day-to-day variations of tau is also described. The similarity of the mean numerical tau model to one obtained using data from a site in Wales (U.K.) suggests that longitude variations of tau may well be small at mid-latitudes. This property has in turn been used to convert a network of ionosonde observations to a database of TEC, for comparisons with a number of currently available ionospheric models. These same ionospheric models were also used to predict values of tau over Hamilton, MA, and the comparisons provided additional model validation. Adjustments to the model profiles were suggested in a couple of cases.

41788 (AD-A-220137/4/XAB) **Survey of equatorial magnetospheric-wave activity between 5 and 8 R(E). Technical report.** Koons, H.C.; Roeder, J.L. Aerospace Corp., El Segundo, CA (USA). Space Sciences Lab. 1 Mar 1990. 27p. (TR-0089(4940-06)-2). Available from NTIS, PC A03/MF A01.

We report the results of a survey of ELV/VLF wave activity in the frequency range from 100 Hz to 5 kHz observed by the SCATHA satellite near the magnetic equator between 5 and 8 R sub E. The typical wave environment in this region is required to assess the role of each type of wave in transport processes, such as the pitch-angle diffusion of electrons, occurring in the outer magnetosphere. Hiss, discrete whistler-mode emissions, and electron cyclotron harmonic waves occur within the frequency range of the SCATHA VLF receiver. Hiss is predominantly observed between noon and dusk where the satellite frequently enters the plasmasphere. Discrete whistler-mode emissions occur over 60% of the time between 0300 and 1200 LT. A surprising result of the survey is the absence of activity in the local time sector from 18 to 21 h. No wave activity above the receiver noise level, 5 x 10 to the minus 7th power V/m-Hz1/2, was detected during 50% of the broadband data acquisitions in this region.

41789 (AD-A-220376/8/XAB) **Ionospheric conductivity dependence of the cross-polar cap potential difference and global Joule heating rate. Final report.** Ahn, B.H.; Kamide, Y.; Akasofu, S.I.; Kroehl, H.W.; Gorney, D.J. Aerospace Corp., El Segundo, CA (USA). 31 Oct 1988. 29p. (TR-0088(3940-06)-9). Available from NTIS, PC A03/MF A01.

Examine the extent to which the cross-polar cap potential difference psi and the global Joule heating rate U, both determined by the magnetogram - inversion method, depend upon the assumed conductance models. For this purpose two statistically determined conductance models and a realistic conductance distribution estimated from bremsstrah-lung X-ray image data have been used. As expected from earlier studies, U is less affected by the choice of conductance models than is psi. This is because U is a globally integrated quantity, and thus the local structures of the electric potential pattern do not affect it appreciably, whereas they are crucial in determining psi, which is defined as the difference between the maximum and minimum potential values usually found in the dawn and dusk sectors, respectively. A comparison between U and psi based on the statistical conductance models and U and psi based on a realistic conductance distribution shows that there are considerable similarities, thus enabling us to use statistical conductance models as a first approximation in deriving such global quantities as the cross-polar cap potential difference and the global Joule heating in the study of solar wind-magnetosphere coupling. Several suggestions are made for improving the present available conductance models and some limitations (possibly intrinsic ones) are also discussed.

41790 (AD-A–220704/1/XAB) **Effects of magnetic storm phases on F-layer irregularities from auroral to equatorial latitudes. Quarterly report, 1 January-31 March 1990.** Aarons, J.; Mendillo, M. Boston Univ., MA (USA). Center for Space Physics. 31 Mar 1990. 3p. Available from NTIS, PC A01/MF A01.

No abstract available.

41791 (AD-A–220705/8/XAB) **Survey of electron cyclotron waves in the magnetosphere and the diffuse auroral electron precipitation.** Roeder, J.L.; Koons, H.C. Aerospace Corp., El Segundo, CA (USA). Laboratory Operations. 9 Mar 1990. 36p. Available from NTIS, PC A03/MF A01.

Original contains color plates: All DTIC/NTIS reproductions will be in black and white.

Narrowband electrostatic wave emissions at frequencies above the local electron cyclotron frequency are known variously as electron cyclotron harmonic (ECH) waves or n+1/2 waves since they tend to occur at odd half-multiples of the electron cyclotron frequency. Natural ECH emissions in the outer magnetosphere are often cited as the electron scattering mechanism which results in the diffuse auroral precipitation. A survey is presented of the characteristics of these waves using data from both the SCATHA and AMPTE-IRM plasma wave instruments. The emissions were observed most often in the 0300-0600 LT sector at L = approx. 4-8 and magnetic latitudes in the range + or - 10 deg. In this region, emissions exceeding 35 microVolt/m were detected only 25% of the time and those exceeding 12 microVolt/m were detected 60% of the time. In agreement with Belmont et al., we consider these amounts grossly insufficient to account for the diffuse auroral electron precipitation by quasilinear pitch angle diffusion.

41792 (AD-A–220859/3/XAB) **Importance of adiabatic variations in trapped-particle distributions observed by the SCATHA satellite. Interim scientific report, March 1987-February 1989.** Bass, J.N.; Gussenhoven, M.S.; Redus, R.H. Air Force Geophysics Lab., Hanscom AFB, MA (USA). 29 Nov 1989. 39p. (GL-TR–89-0233). Available from NTIS, PC A03/MF A01.

Fluxes of trapped 20 keV-1 MeV electrons and ions observed by SCATHA from 5 to 8 R sub E are analyzed for a magnetically quiet and subsequent disturbed period to determine the contribution adiabatic variations make to the observed large variations. The magnetic field is modeled by a dipole distorted by the sum of an azimuthally symmetric and an asymmetric perturbation, which perturbations are empirically determined functions of time. Distribution functions for the disturbed period are predicted from those observed in the quiet period, assuming conservation of the three adiabatic invariants for magnetically trapped particles. The disturbance discussed here is observed during the ascending portion of the SCATHA orbit. The disturbance is first encountered when SCATHA crosses L=6.2R sub E, MLT=2140. It is characterized by a systematic weakening in the plasma sheet magnetic field and concurrent dropouts in the 90 deg. pitch angle high energy electron and ion fluxes. The electron fluxes and the magnetic field remain low for the remainder of this ascending leg, but the ion fluxes recover somewhat for L>7R sub E. The IMF B sub z is small but steadily northward for over 24 hours preceding this period. The solar wind velocity decreases at a slow rate before and during this period, while the solar wind ion density is steadily increasing. For magnetic field decompression, the theory based on conservation of the adiabatic invariants predicts deceleration of equatorially mirroring particles, causing reduction in the fluxes observed at a given energy similar to those seen in the early phase of this event.

41793 (LBL–29019) **Stochastic ion heating by lower hybrid turbulence.** Candy, J. Lawrence Berkeley Lab., CA (USA). May 1990. 56p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00098. Order Number DE90014179. Available from NTIS, PC A04/MF A01; OSTI; INIS; GPO Dep.

Th motion of an ion in a spectrum of lower hybrid waves propagating across a constant magnetic field is examined. In particular, numerical simulation is used to determine the extent to which a turbulent spectrum of these electrostatic waves may accelerate thermal ions (T < 1 eV). The significance of stochastic web development in this heating process is also discussed. 20 refs., 31 figs.

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Refer also to citation(s) 41051, 41111, 41167, 41224, 41228, 41772, 42066, 42071, 42135, 42301

41794 (AD-A–220264/6/XAB) **Low-energy positron-hydrogen scattering. Quarterly report No. 16 (Final), 1 July 1981-30 September 1987.** Girardeau, M.D. Oregon Univ., Eugene, OR (USA). Jan 1988. 25p. Available from NTIS, PC A03/MF A01.

A new mechanism is proposed for atomic recombination in plasmas, whereby the binding energy is carried away by a plasmon. It is suggested that this mechanism may compete with radiative and three-body modes in the case of recombination to sufficiently highly-excited and perturbed states of hydrogen. A procedure for calculation of the transition rate is outlined in a model which treats the plasma oscillations by the Bohm-Pines canonical transformation and the atomic bound states by a second canonical transformation.

41795 (AD-A–220639/9/XAB) **Temperature and kinetic energy dependences of the rate constant for the reaction of O^- with SO_2.** Morris, R.A.; Viggiano, A.A.; Paulson, J.F. Air Force Geophysics Lab., Hanscom AFB, MA (USA). 1990. 4p. Available from NTIS, PC A01/MF A01.

Pub. in Jnl. of Physical Chemistry, Vol. 94, No. 5, 1884-1886(1990).

Rate constants for the reaction of O(-) with Sulfur dioxide have been measured as a function of ion-neutral average center-of-mass kinetic energy ((KEcm)) at each of three temperatures: 203, 295, and 489 K. The temperature dependence of the rate constant is reported here for the first time and is of the form T-(0.27). The energy dependence data are in excellent agreement with a published study and show the overall rate constant decreasing with increasing (KEcm). The energy dependences measured at the different temperatures all lie on one curve, which suggests that the rate constant is independent of the internal temperature of the SO_2 neutral at a given collision energy. The branching ratio between associative detachment and charge transfer was also measured as a function of (KEcm) at the three temperatures. An activation energy of 0.3 eV for the endothermic charge-transfer channel has been derived from the energy dependence of the rate constant for charge transfer.

41796 (IC–90/27) **"Extended" electronic states in a Fibonacci chain.** Kumar, V. International Centre for Theoretical Physics, Trieste (Italy). Feb 1990. 10p. Order Number DE90631713. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

The electronic structure of a one-dimensional binary alloy $A_{1/\tau}B_{1/\tau^2}$ (τ = golden mean) with A and b atoms distributed in a Fibonacci sequence is studied using a tight binding model in which the variation in both the diagonal and off-diagonal terms is treated simultaneously. In contrast to the previous 'diagonal' and the 'off-diagonal' models, for the 'mixed' model we find an extended state.

Also in the limiting case of the 'off-diagonal' model, the state corresponding to E=0 is an extended state. (author). 6 refs, 2 figs.

41797 (JINR-R-4-89-426) **Multichannel calculation of the electric-dipole oscillator strengths for the discrete $^1S^e$-$^1P^0$ transitions in helium within the hyperspherical adiabatic approach.** Abrashkevich, A.G. (Uzhgorodskij Gosudarstvennyj Univ., Uzhgorod (Ukrainian SSR)); Abrashkevich, D.G.; Lend'el, V.I.; Vinitskij, S.I.; Puzynin, I.V.; Gajsak, M.I. Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Computing Techniques and Automation. 1989. 14p. (In Russian). Order Number DE90631718. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

For the first time the electric-dipole matrix elements and oscillator strengths for the dicrete $^1S^e$-$^1P^0$ transitions in helium are calculated with taking into account the nonadiabatic channel coupling. Dependence of the energy values for the ground and single excited states and oscillator strengths on the number of channels is investigated. The good argeement with the results of similar calculations by different methods is obtained. 59 refs.; 5 tabs.

41798 (KEK–89-23) **Proceedings of the KEK topical conference on e^+e^- collision physics.** Shimizu, Yoshimitsu; Takasaki, Fumihiko (eds.). National Lab. for High Energy Physics, Tsukuba, Ibaraki (Japan). Mar 1990. 638p. (CONF-8905220–: KEK topical conference on e^+e_- collision physics, Tsukuba (Japan), 17-19 May 1989). Order Number DE90508150. Available from NTIS (US Sales Only), PC A99/MF A01.

This issue is the collection of the papers presented at the title meeting. The 26 of the presented papers are indexed individually. (J.P.N.).

41799 (KIYI–88-34) **Calculation of single-electron capture cross sections by ions ^+H, He^{+2}, Li^{+3} on collision with light atoms in the framework of continuum intermediate states approximation.** Kovach, A.P.; Lazur, V.Yu.; Mashika, Yu.Yu. AN Ukrainskoj SSR, Kiev (Ukrainian SSR). Inst. Yadernykh Issledovanij. 1988. 40p. (In Russian). Order Number DE90631747. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

In the framework of CIS-approximation the cross sections of electron capture by ions H^+, He^{+2}, Li^{+3} from light atoms were calculated. The cross sections and the transfer probabilities were summed up on degenerated final states in analytical form, using the Coulomb Green's functions. 32 refs.; 8 figs.; 2 tabs.

41800 (LA-UR–90-2092) **Internal dynamics of electrical discharges.** Kadish, A. (Los Alamos National Lab., NM (USA)); Maier, W.B. II; Robiscoe, R.T. Los Alamos National Lab., NM (USA). [1990]. 20p. Sponsored by U.S. Department of Defense. DOE Contract W-7405-ENG-48. (CONF-9009192–1: Discharges and electrical insulation in vacuum, Santa Fe, NM (USA), 17-20 Sep 1990). Order Number DE90013161. Available from NTIS, PC A03/MF A01 - OSTI.

The existence of thresholds for electrical discharge onset suggests a functional relation between macroscopic resistivity and current. At low current, the resistivity should be inversely proportional to the magnitude of the current. Macroscopic models which employ this scaling predict many empirically observed properties of transient electrical discharges, such as (1) thresholds for onset of current, (2) abrupt termination of current in active regions of a current channel, (3) current restart in passive regions of current channels, (4) leaders, and (5) residual charge, both in channels and at sources when current terminates. We present an overview of research with these models and use examples to illustrate the results that have been obtained. We also show how these models predict current channel formation and describe results of efforts to benchmark theory with experimental data. 12 refs., 9 figs.

41801 (N–90-18957, pp. 109-111) **Positron excitation of neon.** Parcell, L.A. (York Univ., Toronto, Ontario (Canada)); Mceachran, R.P.; Stauffer, A.D. National Aeronautics and Space Administration, Greenbelt, MD (USA). Goddard Space Flight Center. 1989. (NASA-CP–3058;REPT–90B00019;NAS–1.55:3058;CONF-8907143–: Workshop on annihilation in gases and galaxies, Greenbelt, MD (USA), 19-21 Jul 1989). In *Annihilation in Gases and Galaxies.* Available from NTIS, PC A12/MF A02.

The differential and total cross section for the excitation of the 3s1P10 and 3p1P1 states of neon by positron impact were calculated using a distorted-wave approximation. The results agree well with experimental conclusions.

41802 (N–90-18957, pp. 285-287) **Initial results of positron ionization mass spectrometry.** Donohue, D.L.; Hulett, L.D. Jr.; Mcluckey, S.A.; Glish, G.L.; Eckenrode, B.A. National Aeronautics and Space Administration, Greenbelt, MD (USA). Goddard Space Flight Center. Jan 1990. (NASA-CP–3058;REPT–90B00019;NAS–1.55:3058;CONF-8907143–: Workshop on annihilation in gases and galaxies, Greenbelt, MD (USA), 19-21 Jul 1989). In *Annihilation in Gases and Galaxies.* Available from NTIS, PC A12/MF A02.

The use of monoenergetic positrons for the ionization of organic molecules in the gas phase is described. The ionic products are analyzed with a time-of-flight mass spectrometer and detected to produce a mass spectrum. The ionization mechanisms which can be studied in this way include positron impact at energies above the ionization limit of the target molecules, positronium formation in the Ore gap energy range, and positron attachment at energies less than 1eV. The technique of positron ionization mass spectrometry (PIMS) may have analytical utility in that chemical selectivity is observed for one or more of these processes.

41803 (ORNL/FTR–3663) **[Seventeenth International conference on the physics of electronic and atomic collisions]: Foreign trip report, June 22, 1990–June 30, 1990.** Datz, S. Oak Ridge National Lab., TN (USA). 12 Jul 1990. 7p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE90014313. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The traveler attended the Executive Committee meeting of the 17 International Conference on the Physics of Electronic and Atomic Collisions (ICPEAC), which will be held in Brisbane, Australia, in July 1991. He then presented a seminar on recombination processes at ENEA for the Department of Fusion in Frascati, Italy.

41804 (ORNL/FTR–3669) **[General Committee of the International Conference on the Physics of Electronic and Atomic Collisions]: Foreign trip report, June 17, 1990–July 3, 1990.** Bottcher, C. Oak Ridge National Lab., TN (USA). 11 Jul 1990. 11p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE90014309. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The traveler participated in the committee meeting which set up the program for the next International Conference on the Physics of Electronic and Atomic Collisions, to be held in Brisbane, Australis. Seminars were presented at Frankfurt, Freiburg, and Paris. Discussions took place covering the following subjects of direct relevance to ORNL programs: pair production in relativistic heavy-ion collisions, angular correlations and post-collision interactions in the Coulomb three-body problem, and interactions of slow, highly charged ions with crystal surfaces. The primary purpose of this trip was to participate in a meeting of the General Committee of the International Conference on the Physics of Electronic and Atomic Collisions, held at Castelgandolfo, near Rome. The subsidiary purpose was to maintain contacts with some of the leading European centers of research in atomic physics, namely Frankfurt (including GSI, Darmstadt), Freiburg, and Paris. Each has historically interacted with programs at ORNL, and members of groups and laboratories from those places are fairly regular visitors to the Physics Division of ORNL. Each is strong in both theory and experiment.

41805 (ORNL/M–1206-Vol.1) **Fifteenth International conference on X-ray and Inner-shell processes: Program Book of Abstracts.** Oak Ridge National Lab., TN (USA); Tennessee Univ., Knoxville, TN (USA); Georgia State Univ., Atlanta, GA (USA). [1990]. 354p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. (CONF-900757–Vol.1-Absts.: 15. international conference on x-ray and inner-shell processes, Knoxville, TN (USA), 9-13 Jul 1990). Order Number DE90013024. Available from NTIS, PC A16/MF A01; OSTI; INIS; GPO Dep.

This document is composed of Abstracts from invited papers presented at X-90, the fifteenth annual international conference on x-ray and Inner-Shell Processes. (FSD)

41806 (SAND–90-1464) **The role of charge exchange in IFR [ion focused regime] relativistic electron beam propagation.** Shokair, I.R. Sandia National Labs., Albuquerque, NM (USA). Jul 1990. 17p. Sponsored by U.S. DOE Energy Research. DOE Contract AC04-76DP00789. Order Number DE90014749. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

Charge exchange results in the transfer of momentum from an ion to a neutral atom, thus it is equivalent to a slowing down mechanism for ions. This might be helpful in IFR propagation of relativistic electron beams. The effect of charge exchange on the ion hose instability and channel expansion after beam passage is investigated in this report. For parameters of interest to current experiments, it is found that the effect on growth of the ion hose instability is insignificant, but there is significant reduction in the energy of the expanding ions after passage of the electron beam. 5 refs., 5 figs.

41807 Long-distance photoinitiated electron transfer through polyene molecular wires. Wasielewski, M.R. (Argonne National Lab., IL (USA). Chemistry Div.); Johnson, D.G.; Svec, W.A.; Kersey, K.M.; Cragg, D.E.; Minsek, D.W. pp. 135-147 of Photochemical energy conversion. Norris, J.R.; Meisel, D. Elsevier Science Pub. Co., Inc., New York, NY (USA) (1989). DOE Contract W-31-109-ENG-38. (CONF-880767–: 7. international conference on photochemical conversion and storage of solar energy, Evanston, IL (USA), 31 Jul - 5 aug 1988).

Long-chain polyenes can be used as molecular wires to facilitate electron transfer between a photo-excited donor and an acceptor in an artificial photosynthetic system. The authors present data here on two Zn-porphyrin-polyene-anthraquinone molecules possessing either 5 or 9 all trans double bonds between the donor and acceptor, 1 and 2. The center-to-center distances between the porphyrin and the quinone in these relatively rigid molecules are 25 Å for 1 and 35 Å for 2. Selective picosecond laser excitation of the Zn-porphyrin and 1 and 2 results in the very rapid transfer of an electron to the anthraquinone in <2 ps and 10 ps, respectively. The resultant radical ion pairs recombine with τ = 10 ps for 1 and τ = 25 ps for 2. The electron transfer rates remain remarkably rapid over these long distances. The involvement of polyene radical cations in the mechanism of the radical ion pair recombination reaction is clear from the transient absorption spectra of 1 and 2, which show strong absorbances in the near-infrared. The strong electronic coupling between the Zn-porphyrin n the anthraquinone provided by low-lying states of the polyene make it possible to transfer an electron rapidly over very long distances.

41808 Rotational level dependence of the electronic quenching of $NH_2\tilde{A}$ by helium. Wysong, I.J. (Molecular Physics Laboratory, SRI International, Menlo Park, California 94025 (USA)); Jeffries, J.B.; Crosley, D.R. *Journal of Chemical Physics (USA)*, 93(1): 237-241 (1 Jul 1990).

The rotational level dependence of the electronic quenching of the $\tilde{A}^2A_1$ state of the NH_2 radical is investigated by time-resolved laser-induced fluorescence. Quenching of $\Sigma(0,9,0)$ is found to increase monotonically with rotational level from 2×10^{-11} cm^3s^{-1} for N'=0 to 7×10^{-11} cm^3 s^{-1} for N'=7. Measurements on the neighboring $\Sigma(0,7,0)$, $\Pi(0,8,0)$, and $\Pi(0,10,0)$ vibronic levels show no significant rotational level dependence. The behavior in $\Sigma(0,9,0)$ cannot be satisfactorily explained by either molecular collision dynamics or by state mixing.

41809 Collisional excitation of $CO_2(01^11)$ by hot hydrogen atoms: Alternating intensities in state-resolved vibrational, rotational, and translational energy transfer. Khan, F.A. (Department of Chemistry, Columbia University, New York, NY (USA)); Kreutz, T.G.; O'Neill, J.A.; Wang, C.X.; Flynn, G.W.; Weston, R.E. Jr. *Journal of Chemical Physics (USA)*, 93(1): 445-451 (1 Jul 1990). DOE Contract FG02-88ER13937.

Time domain tunable diode laser absorption spectroscopy has been used to measure rotationally resolved transient absorption line shapes and nascent rotational populations for CO_2 molecules excited into the (01^11) vibrational state by collisions with translationally hot hydrogen atoms. The even rotational levels are more heavily populated than the odd levels, in agreement with propensity rules derived earlier by Alexander and Clary. The nascent populations and transient linewidths are interpreted in terms of a theoretical model that lends insight into the H–CO_2 collision dynamics. The cross section for exciting (01^11) is ~0.23 times the cross section for exciting (00^01), and ~0.38 times the cross section for exciting (10^00).

41810 Analysis of translational, rotational, and vibrational energy transfer in collisions between CO_2 and hot hydrogen atoms: The three-dimensional "breathing" ellipsoid model. Kreutz, T.G. (Department of Chemistry, Columbia University, New York, NY (USA)); Flynn, G.W. *Journal of Chemical Physics (USA)*, 93(1): 452-465 (1 Jul 1990). DOE Contract FG02-88ER13937.

Classical scattering of a particle from a three-dimensional "breathing" ellipsoid is used to model translational, rotational, and vibrational energy transfer in collisions between hot hydrogen atoms and CO_2. The model combines the theoretical formalism which describes rotational scattering between a particle and a three-dimensional rigid ellipsoid with a simple scheme to account for the effects of CO_2 vibrational excitation. The calculations are used to analyze experimental data (measured using time-domain diode laser absorption spectroscopy) concerning the state-specific deposition of energy among the translational, rotational, and vibrational degrees of freedom of CO_2 following collisions with translationally hot H atoms. The model provides substantial insight into the features of the final-state-resolved experimental data, indicating which "types" of trajectories, e.g., "end-on" vs "broadside" collisions, are responsible for scattering into particular final states. Despite its simplicity, the model is shown to predict virtually *all* of the major features of the experimental data with remarkable accuracy. In addition, it reproduces highly complex behavior seen in the *state–to–state* collision cross sections which had been previously obtained using a data-inversion procedure.

41811 The calculation of excited states with quantum Monte Carlo. II. Vibrational excited states. Bernu, B. (Materials and Chemical Sciences Division, Lawrence Berkeley Laboratory, University of California, Berkeley, CA (USA)); Ceperley, D.M. *Journal of Chemical Physics (USA)*, 93(1): 552-561 (1 Jul 1990). DOE Contract AC03-76SF00098.

Using a new Monte Carlo method for computing properties of excited quantum states, correlation function quantum Monte Carlo, we calculate the lowest ten vibrational excited state energies of H_2O and H_2CO in the Born–Oppenheimer approximation. The statistical errors for H_2O are 0.1 cm^{-1} for the ground state and 15 cm^{-1} for the tenth excited state while for H_2CO they are 2 cm^{-1} for the ground state and 30 cm^{-1} for the eighth excited state. The algorithm presented here is easily extensible to larger systems.

41812 An *ab initio* study of the magnetic hyperfine properties of $F^-_2(^2\Sigma^+_u)$. Feller, D. (Molecular Science Research Center, Pacific Northwest Laboratory, Richland, Washington 99352 (USA)). *Journal of Chemical Physics (USA)*, 93(1): 579-589 (1 Jul 1990). DOE Contract AC06-76RL01830.

Gaussian basis sets derived from the new Dunning "correlation consistent" sets have been used in conjunction with multireference single- and double-excitation configuration interaction (CI) wave functions to determine the magnetic hyperfine properties of the F^-_2 radical anion and the electron affinity of F_2. The best computed values, using an extension to the polarized, valence quadruple zeta basis (cc-pVQZ) are: $A_{iso}(^{19}F)$=772 MHz (expt=785 MHz), A_{dip}=890 MHz (expt=901 MHz), and EA=2.61 eV (expt=3.08±0.10 eV). Estimates which crudely account for basis set incompleteness and CI truncation lead to the following, slightly different, values: A_{iso} (^{19}F)=802 MHz, A_{dip} =898 MHz, and EA=2.94 eV. The sensitivity of A_{iso} to changes in the F–F bond length results in an uncertainty on the order of ±20 MHz in the isotropic hyperfine property. Such close agreement between theory and experiment suggests that any rare gas matrix effect in the recent electron spin resonance (ESR) measurements on F^-_2 should be small, i.e., the matrix results should agree well with any future gas phase values. Correlation effects beyond the standard singles and doubles level are estimated to contribute approximately 50 MHz (~30%) of the 155 MHz correlation correction to A_{iso}.

41813 Isotropic coupling constant for the nitrogen atom from correlated calculations based on spin-unrestricted wave

functions. Carmichael, I. (Radiation Laboratory, University of Notre Dame, Notre Dame, Indiana 46556 (USA)). *Journal of Chemical Physics (USA)*, 93(1): 863-864 (1 Jul 1990).

The isotropic hyperfine coupling constant for the ground electronic state of the nitrogen atom is computed from the quadratic configuration interaction correlation procedure based on a single unrestricted Hartree–Fock (UHF) determinant. The splitting is determined from the normalized spin density at the nucleus, derived by finite-field perturbation theory. Results obtained are compared with previous work based on spin-restricted reference spaces. Close accord is found between present estimates and full configuration interaction values for small basis sets. Contributions from shells of higher angular momentum functions in the basis set are similar in both approaches and for the largest unrestricted calculation the correlated results are in good accord with experiment. The UHF wave function is shown to provide a reasonable account of the *K*-shell contribution to the isotropic coupling and hence the UHF-based correlated calculations show much less sensitivity to the neglect of core–electron correlation than the dramatic effects observed in spin-restricted treatments.

41814 **Guided ion beam studies of the state-specific reactions of Fe^+ (^6D,^4F) with CH_3X (X = Cl, Br, I).** Fisher, E.R. (Univ. of Utah, Salt Lake City (USA)); Schultz, R.H.; Armentrout, P.B. *Journal of Physical Chemistry (USA)*, 93(21): 7382-7387 (19 Oct 1989).

Reactions of Fe^+ with CH_3X (X = Cl, Br, I) are studied by guided ion beam techniques. State-specific reaction cross sections for production of $FeCH_3^+$ and FeX^+ are presented for the ^6D ground and the ^4F first excited states of Fe^+. The overall behavior seen in these reactions is similar to that seen in the analogous reactions of Co^+ and Ni^+, discussed in the preceding paper in this issue. The two states of Fe^+ exhibit large differences in reactivity, with the ^4F state generally being more reactive than the ^6D state for production of FeX^+ and $FeCH_3^+$. The only exception is for the exothermic formation of $FeCH_3^+$ below 0.7 eV in the CH_3I system. We postulate that this is due to a potential energy surface crossing that is avoided at low kinetic energies due to spin-orbit interactions and is permitted at higher energies. Analysis of the threshold behavior of the endothermic reactions provides two determinations of $D°(Fe^+\text{-}CH_3) = 2.49 \pm 0.13$ and 2.47 ± 0.07 eV, in good agreement with previous values. Lower limits are placed on the bond energies for Fe^+-X.

41815 **Spectral grid study of Ro-vibrational coupling in H_2-metal scattering.** Jackson, B. (Univ. of Massachusetts, Amherst (USA)). *Journal of Physical Chemistry (USA)*, 93(22): 7699-7702 (2 Nov 1989).

A theoretical technique is presented that allows one to quantum mechanically describe the rotational and vibrational behavior of diatomic molecules that experience nonegligible ro-vibrational coupling. Such situations arise when molecules have a strong electronic interaction with a metal, leading to variations in the bond length, or dissociative adsorption. The approach uses the spectral-grid method, in which the molecular wave function is represented by its values on a fixed grid of points in space. This wave function is evolved in time, scattered from the surface, and used to compute all properties of interest. The ro-vibrational part of the wave function is treated exactly, avoiding the usual rigid-rotor approximation. The rotationally inelastic diffraction of H_2, HD, and D_2 from a metal surface is examined. It is found that small variations in the molecular bond length near the surface can lead to significant variations in the rotationally inelastic scattering probabilities. This is important since many metals interact chemically with H_2, and their scattering probabilities are often used to extract information about the gas-surface potential. Applications of the method to other problems are discussed.

6404 Fluid Physics

Refer also to citation(s) 40895, 41292, 42150, 42309

41816 (UCRL–102303) **Analysis of near-surface flow physics in a two-stage, 10 km/s, electromagnetic launcher.** Buckingham, A.C.; Hawke, R.S. Lawrence Livermore National Lab., CA (USA). 6 Jun 1990. 8p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-9006153–2: 21. AIAA fluid dynamics, plasmadynamics and laser conference in conjuction with the AIAA 25th thermophysics and heat transfer conference and the 16th aerodynamic ground testing conference, Seattle, WA (USA), 18-20 Jun 1990). Order Number DE90013292. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

This is a report of progress in the analysis of several apparently influential physical processes observed in current electromagnetic launcher performance experiments. Boundary layer and thin-film Couette flow processes in the hypervelocity range (approaching 10 km/s) are the focus of this work. The specific launch device under study has a two-stage acceleration: initially a light gas projectile injection phase followed by a plasma driven Lorentz force acceleration phase. Our emphasis is on understanding the concomitant influence of plasma transport, gas phase and gas/solid kinetics, skin depth, solid neutral and ionic particle seed additives on near-wall boundary layer and Couette flow processes. Studies are initiated on the effects of plasma-enriching ion additives and wall transpiration cooling with respect to increasing the integrity, performance, and launch-to-launch endurance of this type of electromagnetic launcher (EML). 14 refs., 8 figs.

41817 (UCRL–102304) **Interactive shock structure response to passage through turbulence.** Buckingham, A.C. Lawrence Livermore National Lab., CA (USA). 6 Jun 1990. 8p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-9006153–3: 21. AIAA fluid dynamics, plasmadynamics and laser conference in conjuction with the AIAA 25th thermophysics and heat transfer conference and the 16th aerodynamic ground testing conference, Seattle, WA (USA), 18-20 Jun 1990; AIAA–90-1642 Order Number DE90013293. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

This discussion is on the apparent random changes to shock transitional velocity, density, and temperature induced when weak- to moderate-strength shocks interact with relatively intense, preshocked turbulence. The shock fronts appear to ripple or distort randomly and unsteadily. Shocks amplify and alter the spectral structure of turbulent fields with which they interact. Questions develop about the mechanisms significant in this interaction. Consideration is given to the significance of this process in enhancing turbulent mixing and transport, and to the evolution and decay of the intensified turbulence during and after such an interaction process. Analysis of this process should provide insight and a firmer basis for the development and test of more effective, consistent compressible turbulence models, and for the interpretation, design, and analysis of related experiments. At the present stage, particular emphasis is placed on determining estimates of the gross partition of directed shock energy into turbulent kinetic energy, and on fine-scale modal partition between acoustic, entropy, and vorticity fields during interactions. 13 refs., 9 figs., 2 tabs.

41818 **"Breakthrough" via dipolar-vortex/jet formation in shock-accelerated density-stratified layers.** Yang, X. (Department of Mechanical and Aerospace Engineering, Rutgers University, Piscataway, NJ (USA)); Zabusky, N.J.; Chern, I. *Physics of Fluids A (USA)*, 2(6): 892-895 (Jun 1990). DOE Contract W-31109-ENG-38.

Convective "breakthrough" after an *inclined planar light fluid layer* is struck by a shock wave is observed and quantified. The results of direct numerical simulations are interpreted and a convective breakthrough time t_b is quantified. Initially, vorticity of opposite sign is deposited on each interface of the layer. Breakthrough occurs when these vortex regions approach and "bind" into a dipolar vortex (or jet head) that moves away from the wall. Variations of t_b with Mach number of the incoming shock waves are given.

41819 **Effect of rigid boundaries on the onset of convective instability in a triply diffusive fluid layer.** Lopez, A.R. (Department of Aerospace and Mechanical Engineering, University of Arizona, Tucson, Arizona 85721 (USA)); Romero, L.A.; Pearlstein, A.J. *Physics of Fluids A (USA)*, 2(6): 897-902 (Jun 1990). DOE Contract AC04-76DP00789.

The onset of convection in a triply diffusive, incompressible motionless Newtonian fluid layer of infinite horizontal extent bounded by rigid parallel walls is studied by means of a linear stability analysis. The qualitative features of most of the results carry over from

the case of stress-free boundaries studied earlier by Pearlstein, Harris, and Terrones [J. Fluid Mech. 202, 443 (1989)]. One striking feature that does not carry over from the stress-free case, however, is the possibility of quasiperiodic bifurcation from the steady motionless state via two pairs of complex conjugate temporal eigenvalues with incommensurable imaginary parts crossing into the right half-plane at the same combination of Rayleigh numbers. The impossibility of this type of quasiperiodic bifurcation from the rest state in the rigid case is discussed in terms of the topology of the disconnected neutral curves. The numerical method employed is suitable for the computation of disconnected oscillatory neutral curves in other stability problems for which a low-order exact dispersion relation does not exist.

41820 **The effect of Mach number on the stability of a plane supersonic wake.** Chen, J.H. (Department of Mechanical Engineering, Stanford University, Stanford, California 94305 (USA)); Cantwell, B.J.; Mansour, N.N. *Physics of Fluids A (USA)*, 2(6): 984-1004 (Jun 1990). DOE Contract AC04-76DP00789.

Recent interest in supersonic combustion and problems of transatmospheric flight has prompted renewed research efforts in laminar–turbulent free-shear flow transition. In the present work, the influence of Mach number on the stability of supersonic planar wake flows is investigated to gain insight into the physics of linear, nonlinear, and three-dimensional (3-D) stages of transition. The effect of varying the relative phase difference between a fundamental instability mode and its subharmonic is investigated as a possible means of controlling the evolution of a wake. From a linear stability analysis, it is found that the influence of increasing Mach number is stabilizing, resulting in a growth rate at a Mach number of 3 which is 60% that of an incompressible wake. Direct numerical simulations of the time-dependent compressible Navier–Stokes equations in two and three dimensions are performed for a forced time-developing wake using a spectral collocation method. The results of the two-dimensional (2-D) simulations show the slow rollup of spanwise vortices at high Mach numbers that is attributed to the influence of baroclinic and dilatational effects. Finally, the results of three-dimensional simulations forced with the most unstable Kelvin–Helmholtz wave and a pair of oblique three-dimensional waves show that, depending on the initial phasing between the 2-D and 3-D waves, vortex loops may or may not form as a result of the interaction between the streamwise and spanwise vorticity.

41821 **Analysis of the boundary conditions for a Hele–Shaw bubble.** Burgess, D. (Department of Physics, Ohio State University, Columbus, OH (USA)); Foster, M.R. *Physics of Fluids A (USA)*, 2(7): 1105-1117 (Jul 1990). DOE Contract FG02-88ER13916.

Effective boundary conditions are derived to be used with the classical Hele–Shaw equations in calculating the shape and motion of a Hele–Shaw bubble. The main assumptions of this analysis are that the displaced fluid wets the plates, and that the capillary number Ca and the ratio of gap width to characteristic bubble length ϵ are both small. In a small region at the sides of the bubble, it is found that the thin-film thickness scales with $\epsilon^{2/5}$ $Ca^{4/5}$, rather than the $Ca^{2/3}$ scaling that is valid over most of the thin film above and below the bubble.

41822 **Linear stability of a rotating film flow attached inside a circular cylinder.** Fujimura, K. (Japan Atomic Energy Research Institute, Tokai-mura, Ibaraki 319-11 (Japan)). *Physics of Fluids A (USA)*, 2(7): 1182-1190 (Jul 1990).

Stability of a rotating film flow attached inside a circular cylinder was analyzed on a linear basis, where the cylinder is at rest and the basic flow is assumed to be kept rotating under the imposition of an artificial body force acting in the azimuthal direction. A traveling-wave mode that is intrinsic for a film flow on a vertical or an inclined flat plate and a centrifugal instability mode are obtained as unstable modes. The effect of a superimposed shear flow in the axial direction was also examined and it was shown that the shear flow exerts a stabilizing effect on the centrifugal instability mode.

41823 **Influences of swirl on the structure and extinction of strained premixed flames. Part I: Moderate rates of rotation.** Libby, P.A. (Department of AMES, University of California San Diego, La Jolla, California 92093 (USA)); Williams, F.A.; Sivashinsky, G.I. *Physics of Fluids A (USA)*, 2(7): 1213-1223 (Jul 1990). DOE Contract FG03-86ER13527 ;FG02-88ER13822.

The characteristics of isenthalpic planar premixed flames in counterflowing, high Reynolds number streams with counter- and corotating swirl are analyzed by activation energy asymptotics for a one-step Arrhenius reaction with small departures from unity Lewis numbers. Density changes resulting from heat release are fully taken into account. For moderate rates of rotation, the situation considered in the present study, there is only one stagnation plane that is coincident with the plane of symmetry separating the inviscid outer flows and that involves a viscous layer with an embedded flame in some circumstances. The analysis of a flame in the viscous layer is relevant to the experimentally observed variation of the lean flammability limit with the rotation rate. Comparison with the existing experimental data is carried out.

41824 **The tracking force on a relativistic electron beam in an Ohmic plasma channel.** O'Brien, K.J. (Sandia National Laboratories, Albuquerque, New Mexico 87185 (USA)). *Physics of Fluids B (USA)*, 2(7): 1666-1675 (Jul 1990). DOE Contract AC04-76DP00789.

The linearized tracking force on an electron beam propagating slightly off axis in an Ohmic plasma channel is calculated. Electron inertial effects are included in Ohm's law. The channel of conductivity (σ), density (n_e), and radius (a) is surrounded by a region of ambient plasma with conductivity (σ_0), density (n_{e0}), and radius (b). Enclosing the system is a highly conducting metallic tank. The electromagnetic fields are calculated using the frozen-field approximation of the Maxwell field equations. The fields are expanded into monopole and dipole moments linearized in the small parameter (d/a), where (d) is the beam displacement. The electron beam is assumed to be a rigid cylinder of charge propagating at the speed of light through the channel and is not allowed to respond dynamically to the force.

41825 **Atomic motions in liquid KPb: A molecular-dynamics investigation.** Toukan, K. (Argonne National Laboratory, 9700 South Cass Avenue, Argonne, Illinois 60439-4843 (USA)); Reijers, H.T.J.; Loong, C.; Price, D.L.; Saboungi, M. *Physical Review, B: Condensed Matter (USA)*, 41(17): 11739-11742 (15 Jun 1990). DOE Contract W-31109-ENG-38.

A molecular-dynamics computer simulation is used to determine velocity and current-density autocorrelation functions for a liquid system consisting of K^+ and Pb_4^{4-} ions. The calculated structure of this system is in excellent agreement with that determined experimentally for liquid KPb alloys. The calculations provide an interpretation for recent inelastic-neutron-scattering results, which do not show any distinct vibrational modes characteristic of Pb_4^{4-} tetrahedra.

6450 High Energy Physics

Refer also to citation(s) 42316

41826 (ANL-HEP-TR–90-65) **Argonne National Laboratory, High Energy Physics Division, semiannual report of research activities, July 1, 1989–December 31, 1989.** Argonne National Lab., IL (USA). [1989]. 91p. Sponsored by U.S. DOE Energy Research. DOE Contract W-31109-ENG-38. Order Number DE90014384. Available from NTIS, PC A05/MF A01; OSTI; INIS; GPO Dep.

This report discusses research being conducted at the Argonne National Laboratory in the following areas: Experimental High Energy Physics; Theoretical High Energy Physics; Experimental Facilities Research; Accelerator Research and Development; and SSC Detector Research and Development.

41827 (DOE/ER/40380–2) **HUGS at CEBAF: Proceedings of the Hampton University Graduate Studies at the Continuous Electron Beam Accelerator Facility.** Buck, W.W. (ed.). Hampton Univ., VA (USA). Dept. of Physics. [1989]. 319p. Sponsored by U.S. DOE Energy Research. DOE Contract FG05-87ER40380. (CONF-8905332–: 4. Hampton University graduate studies (HUGS) at the continuous electron beam accelerator facility (CEBAF), Hampton,

VA (USA), 30 May - 17 jun 1989). Order Number DE90013957. Available from NTIS, PC A15/MF A01; OSTI; INIS; GPO Dep.

This report contains papers on the following topics: breaking and restoration of Chiral symmetry; an introduction to the QCD quark model and hadron spectroscopy; observations of ultra high energy emission from Cygnus X-3; parity violation program at CEBAF; testing the standard model via nuclear current interactions; collective models in excited nuclei and excited baryons; cold fusion; Δ electroproduction and inelastic charge scattering from carbon and iron; electron scattering and sum rules in nuclear physics; nuclear matter saturation in a U(1) ⊗ Chiral model; effective action in path integral approach for a scalar field theory; many body approach to electron scattering; non-resonant N-N pion production; large N_c expansion, from QCD to Skyrme; relativistic methods for few-body systems; and structure of excited nuclei and baryons (breaking of reflection symmetry).

41828 (JINR-D-1,2-88-652/v.1) **Proceedings of the 9. International seminar on high energy physics problems. V. 1.** Joint Inst. for Nuclear Research, Dubna (USSR). 1988. 454p. (In Russian). (CONF-8806225--: 9. international seminar on high energy physics problems relativistic nuclear physics and quantum chromodynamics, Dubna (USSR), 14-19 Jun 1988). Order Number DE90706115. Available from NTIS (US Sales Only), PC A20/MF A01; OSTI; INIS.

Individual papers in these proceedings are indexed separately.

6451 Particle Interactions and Properties - Experimental

Refer also to citation(s) 41441, 41484, 41929, 41932, 41947, 41948, 41979, 41982, 41984, 41990, 41992, 42011, 42013, 42048, 42051

41829 (ANL-HEP-CP-90-54) **Fractal structure in multiparticle production in e^+e^- annihilations at 29 GeV.** Sugano, K. Argonne National Lab., IL (USA). High Energy Physics Div. [1990]. 8p. Sponsored by U.S. DOE Energy Research. DOE Contract W-31109-ENG-38. (CONF-9005245--1: International workshop on correlations and multiparticle production (CAMP), Marburg (Germany, F.R.), 14-16 May 1990). Order Number DE90013677. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

The fractal structure in multiparticle production in e^+e^- annihilations at 29 GeV has been studied using the HRS detector at PEP. Very high fractal moments have been measured and their implications are discussed in terms of an α-model and a thermodynamical model. Two-dimensional fractal moments in the rapidity and azimuthal angle space have also been measured and the results are compared to the Lund string model predictions. 6 refs., 2 figs.

41830 (DOE/ER/40399-3) **Study of neutron-proton interaction in the 300–700 MeV energy region: Progress report, September 1989–June 1990.** Northcliffe, L.C.; Hiebert, J.C. Texas A and M Univ., College Station, TX (USA). Dept. of Physics. Jun 1990. 33p. Sponsored by U.S. DOE Energy Research. DOE Contract FG05-88ER40399. Order Number DE90014350. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

The experimental programs supported by the present grant is a continuation of the work supported under DOE Contract AS05-76ER04449. More detailed discussion of the experimental apparatus and earlier activities can be found in annual reports for that contract and this grant. The primary objective of the program is investigation of the nucleon-nucleon (NN) interaction, in the medium-energy region, in both elastic and inelastic channels.

41831 (FNAL/C–90/125-E) **Preliminary results from E665 on cross-section ratios at low x_{bj} using H_2, D_2 and Xe targets.** Aied, S. (Maryland Univ., College Park, MD (USA)). The E665 Collaboration. Fermi National Accelerator Lab., Batavia, IL (USA). Jun 1990. 9p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76CH03000. (CONF-9004112–3: Workshop on hadron structure functions and parton distributions, Batavia, IL (USA), 26-28 Apr 1990). Order Number DE90014387. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

Fermilab experiment 665 has taken deep-inelastic muon scattering data at a beam energy of 490 GeV/c, on H_2, D_2 and Xe targets. Two triggers have been used: a large scattering-angle trigger (LAT), sensitive to a minimum scattering angle of 3 mrad, and a small scattering-angle trigger which can accept a scattering angle down to 0.5 mrad. The neutron to proton ratio is reported for x_{bj} above 0.002, and it shows consistency with 1 as x_{bj} goes to 0. The Xe to D_2 cross-section ratio is reported for x_{bj} above 0.001 and it shows evidence of shadowing. 5 refs., 5 figs.

41832 (FNAL/C–90/126-E) **Muon interactions at 490 GeV.** Schmitt, M. (Fermi National Accelerator Lab., Batavia, IL (USA)). The E665 collaboration. Fermi National Accelerator Lab., Batavia, IL (USA). Jun 1990. 10p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76CH03000. (CONF-9003161–9: 25. Rencontres de Moriond on QCD and hadronic interactions conference, Les Arcs (France), Mar 1990). Order Number DE90014386. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

E665 is a new, high-energy muon scattering experiment at Fermilab. Data were taken with a 490 GeV muon beam incident on deuterium, hydrogen, and xenon targets during the 1987–88 fixed target run. These data are being analyzed with various physics objectives in mind, and a number of preliminary results have been obtained. This paper presents four of results, specifically the small x_{Bj} ratio of xenon and deuterium cross sections, inclusive hadron distributions, two jet signals, and exclusive ρ^0 production.

41833 (FNAL/C–90/127-E) **Xe/D_2 cross-section ratios at low X_{Bj} from muon scattering at 490 GeV/c.** Magill, S.R. The E665 collaboration. Fermi National Accelerator Lab., Batavia, IL (USA). Jun 1990. 6p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76CH03000. (CONF-900193–3: Division of particle, Houston, TX (USA), 2 Jan 1990). Order Number DE90014385. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

First measurements from the E665 experiment at Fermilab on the relative cross-sections of 490 GeV/c muons scattered from deuterium and xenon targets are presented. The scattered muons were in the kinetic range $Q^2 > 0.1(GeV/c)^2$ and very low x_{Bj} ($0.001 < x_{Bj} < 0.1$). Triggering on events in this kinematic region was accomplished with a special Small Angle Trigger which projected individual beam muons to form a veto region 30 meters from the target. Using this trigger, muons with scattered angles as small as 0.5 milliradians were detected. 8 refs., 6 figs.

41834 (IFVE-ONF–89-120) **Inclusive production of meson resonances in K^+p interactions at 250 GeV/c.** Agababyan, N.M. (Erevanskij Fizicheskij Inst., Erevan (USSR)); Azhinenko, I.V.; Belokopytov, Yu.A. Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Serpukhov (USSR). Inst. Fiziki Vysokikh Ehnergij. 1989. 48p. (In Russian). Order Number DE90632439. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

A detailed analysis of the inclusive production of the vector mesons Φ, $K^{*,0}(892)$, K-bar$^{*0}(892)$, $\rho^{+,0}$, ω and the tensor mesons $K^{*0}{}_2(1430)$ and $f_2(1270)$ in K^+p interactions at 250 GeV/c is presented. The data are compared with results at lower energies and with predictions of various quark-parton models. The production of ρ^0, $K^{*0}(892)$ and K-bar$^{*0}(892)$ increases at the same rate as a function of energy, is concentrated in the central region and is not reproduced by the models. Production of the tensor mesons $f_2(1270)$ and $K_2{}^{*0}(1430)$ is suppressed relative to ρ^0 and $K^{*0}(892)$ by a factor of about 3. 33 refs.; 17 figs.; 9 tabs.

41835 (INS–809) **f_2 dominance of the energy-momentum tensor.** Terazawa, Hidezumi. Tokyo Univ., Tanashi (Japan). Inst. for Nuclear Study. Feb 1990. 8p. Order Number DE90508027. Available from NTIS (US Sales Only), PC A02/MF A01.

By assuming f_2 dominance of the energy-momentum tensor and by using the Ward identity for the vertex function of the trace of the energy-momentum tensor and the two electromagnetic currents, the partial decay width of $f_2 \to \gamma\gamma$ is estimated to be 1.9 ± 0.2 keV, which is in a good agreement with the latest experimental data of 2.27 ± 0.47 (stat.) ± 0.11(syst.) keV by the TOPAZ Collaboration in TRISTAN. (author).

41836 (ITEF–56-89) **Physics at a $c\tau$ factory.** Voloshin, M.B.; Danilov, M.V.; Zajtsev, Yu.M. Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow (USSR). Inst. Teoreticheskoj i Ehksperimental'noj Fiziki. 1989. 33p. (In Russian).

Order Number DE90632394. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Consideration is given to a series of physical problems, which can be solved at $c\tau$-factory-electron-positron collider, overlapping the energy range $\sqrt{s}$=3-5 GeV and with luminosity of the order of $10^{33}cm^{-2}s^{-1}$. Potentialities of $c\tau$ factory are correlated with the same ones of existing colliders, operating in the same energy region. Main requirements for universal detector, which could enable realize the considered program of investigations are discussed. 32 refs.; 1 fig.

41837 (ITEF–103-89) **Measurement of the $K^+ \to \mu^+ \nu\gamma$ decay probability.** Demidov, V.S.; Dobrokhotov, V.A.; Lyublev, E.A.; Nikitenko, A.N. Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow (USSR). Inst. Teoreticheskoj i Ehksperimental'noj Fiziki. 1989. 24p. (In Russian). Order Number DE90632435. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Experimental restrictions on the values of vector (F_V) and axial-vector (F_A) form factors for structural radiation of gamma quanta in $K^+ \to \mu^+ \nu\gamma$ decay $-1.5 < F_V M < 0.8$ and $-07 < F_A M < 1.6$ M-mass of K meson, as well as for sum and difference of these form factors $(F_V+F_A)M < 1.3$ and $-2.3 < (F_V-F_A)M < 0.7$ at 90% level of assurance were obtained. The experiment was performed with the use of images of 700-liter xenon bubble chamber. The ratio of experimental value of probability of internal bremsstrahlung (W_T) to theoretical value, calculated according to quantum electrodynamics (W_e) for this decay was obtained: $W_e/W_T = 1.13 \pm 0.13$. 20 refs.; 6 figs.

41838 (ITEP–62-89) **Inelastic electron-nucleus interactions at 5 GeV detected by ARGUS.** Degtyarenko, P.V.; Efremenko, Yu.V.; Gavrilov, V.B.; Leksin, G.A.; Semenova, N.L. Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow (USSR). Inst. Teoreticheskoj i Ehksperimental'noj Fiziki. 1989. 29p. Order Number DE90632472. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Beam-gas events taken with the ARGUS detector at the e^+e^--storage ring DORIS-2 have been used to study eA interactions at 5 GeV. The selection of $e^{\pm}$ $^{14}N(^{16}O)$ events is discussed. The spectra of secondary protons and charged pions are found to be similar to those of hA interactions in accordance with the nuclear scaling. Measurements of like-particle (pp and $\pi\pi$) correlations at small relative momenta were used to determine the radius of particle emission region in eN(O) interactions. This radius proved to be equal within errors to the radius of particle emission region in hC interactions. No any narrow diproton resonance has been observed in the mass region from 1.9 to 2.2 GeV. 27 refs.; 11 figs.

41839 (ITEP–111-89) **Asymmetry in $\pi^- p\uparrow$ elastic scattering in momentum range 1.4-2.1 GeV/c.** Alekseev, I.G. (and others); Budkovskij, P.E.; Kanavets, V.P. Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow (USSR). Inst. Teoreticheskoj i Ehksperimental'noj Fiziki. 1989. 27p. Order Number DE90632471. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Results of systematic measurements of the asymmetry parameter in the elastic scattering of pions on polarized protons at 1.4-2.1 GeV/c in the back hemisphere are presented together with a test of the isospin invariance of the data set available on pion-proton scattering in the investigated momentum range. The obtained data and amplitude reconstruction results are compared with the current phase shift analysis predictions. 22 refs.; 10 figs.

41840 (JINR-D–1,2-88-652/v.1, pp. 190-211) **Particle production in nuclear collisions and dissociation of nuclei into nucleons.** Stavinskij, V.S. (Joint Inst. for Nuclear Research, Dubna (USSR)). Joint Inst. for Nuclear Research, Dubna (USSR). 1988. (In Russian). (CONF-8806225–: 9. international seminar on high energy physics problems relativistic nuclear physics and quantum chromodynamics, Dubna (USSR), 14-19 Jun 1988). In *Proceedings of the 9. International seminar on high energy physics problems. V. 1.* Order Number DE90706115. Available from NTIS (US Sales Only), PC A20/MF A01; OSTI; INIS.

An attempt to classify experimental data and to present new approach for the problem of cumulative production of particles and high-transverse momentum particles ($\pi^{\pm}$, $k^{\pm}$, p, p-bar, d) on Li^6, Be, Mg, Si, $^{54.56.58}Fe$, $^{58.61.64}Ni$, Cu, ^{64}Zn, $^{112.118.124}Sn$, $^{144.154}Sm$, $^{182.186}W$, U nuclei is made in the review. Particle cumulative production, quark-parton structure function, A dependence of particle production on nuclei and in nuclear collisions and A dependence of inclusive cross sections of particle cumulative production are discussed. Reactions with dissociation on nucleons of deuteron, helium and compound nuclei are considered. Possibility of unified description of different processes is discussed in terms of nucleus fluctron model. 35 refs.; 22 figs.

41841 (JINR-D–1,2-88-652/v.1, pp. 212-218) **Limiting fragmentation of protons with the $\pi^{\pm}$, $K^{\pm}$, p(or p-bar) production in excitation by protons and deuterons with 8.9 GeV/c momentum.** Giordehnesku, N. (Joint Inst. for Nuclear Research, Dubna (USSR)); Greku, V.; Zborovskij, I.; Litvinenko, A.G.; Panebrattsev, Yu.A.; Pentsya, M.; Stavinskij, V.S.; Khoroj, M. Joint Inst. for Nuclear Research, Dubna (USSR). 1988. (In Russian). (CONF-8806225–: 9. international seminar on high energy physics problems relativistic nuclear physics and quantum chromodynamics, Dubna (USSR), 14-19 Jun 1988). In *Proceedings of the 9. International seminar on high energy physics problems. V. 1.* Order Number DE90706115. Available from NTIS (US Sales Only), PC A20/MF A01; OSTI; INIS.

Proton limiting fragmentaion with $\pi^{\pm}$, $K^{\pm}$, p, p-bar cumulative production in pp- and dp-interactions at 8.9 GeV/c projectile momentum was investigated. Experimental values of inclusive cross sections of $\pi^{\pm}$-meson production for 180 deg observation angle dependning on their energy are obtained. Cross sections of $\pi^{\pm}$ and $K^{\pm}$ production for 62 deg observation angle depending on their energy are measured both for pp- and dp-interactions. Angular dependence of production cross section for p, π^+ and K^+ mesons in pp interactions is measured. Description algorithm for the obtained experimental information in conjunction with other effort data is presented. 11 refs.; 4 figs.

41842 (JINR-D–1,2-88-652/v.1, pp. 219-228) **Production of cumulative pions and kaons.** Boyarinov, S.V. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow (USSR). Inst. Teoreticheskoj i Ehksperimental'noj Fiziki); Gerzon, S.A.; Evseev, I.I. Joint Inst. for Nuclear Research, Dubna (USSR). 1988. (In Russian). (CONF-8806225–: 9. international seminar on high energy physics problems relativistic nuclear physics and quantum chromodynamics, Dubna (USSR), 14-19 Jun 1988). In *Proceedings of the 9. International seminar on high energy physics problems. V. 1.* Order Number DE90706115. Available from NTIS (US Sales Only), PC A20/MF A01; OSTI; INIS.

$\pi^{\pm}$ and $K^{\pm}$ cumulative production in $pA \to \pi^{\pm}+x$ and $pA \to K^{\pm}+x$ reactions at 10.14 GeV proton beam energy on nuclei (Be-Ta) was invesigated. Measurements were conducted using FAS-1 focusing hadron spectrometer. Invariant cross sections of $\pi^{\pm}$ and $K^{\pm}$ cumulative production, values of ratio of this cross sections, dependences of production cross sections for pions and kaons on cumulative number and mass number of nucleus target, as well as on transverse momentum are measured. Difference of cumulative meson spectra occurring in different nuclei fragmentation is discussed in terms of fluctron model. 17 refs.; 14 figs.

41843 (JINR-D–1,2-88-652/v.1, pp. 229-236) **Comparison of backward particle production from ν-neon and ν-D.** Guy, J. (Rutherford Appleton Lab., Chilton (UK)). Joint Inst. for Nuclear Research, Dubna (USSR). 1988. (CONF-8806225–: 9. international seminar on high energy physics problems relativistic nuclear physics and quantum chromodynamics, Dubna (USSR), 14-19 Jun 1988). In *Proceedings of the 9. International seminar on high energy physics problems. V. 1.* Order Number DE90706115. Available from NTIS (US Sales Only), PC A20/MF A01; OSTI; INIS.

Review of experimental data for protons and charged pions produced backward in ν-Ne, ν-D, ν-bar-N, ν-bar-D interactions with more than 350 MeV/c momenta of bombarding particles is given. Measured differential distributions (p^2) for p, π^+, π^- backward produced particles, slope parameter B of spectrum and its angular dependence shown as energy function for neon target are presented. The obtained data for backward produced protons are compared with predictions of intranuclear cascade model and two-nucleon correlation model. The conducted analysis of data has shown, that invariant p^2-distributions of backward produced protons

on neon target are similar to the observed ones in experiments for other beams and tagets. Number of such protons with more than 350 MeV/c momentum results in value of two-nucleon correlation by 10±3 times higher than for ν on deuterium target that is 12±5 for ν-bar respectively. 27 refs.; 6 figs.; 3 tabs.

41844 (JINR-D–1,2-88-652/v.1, pp. 237-257) **Production of hadrons with large transverse momenta in hadron-nuclear collisions.** Sulyaev, R.M. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Serpukhov (USSR). Inst. Fiziki Vysokikh Ehnergij). Joint Inst. for Nuclear Research, Dubna (USSR). 1988. (In Russian). (CONF-8806225–: 9. international seminar on high energy physics problems relativistic nuclear physics and quantum chromodynamics, Dubna (USSR), 14-19 Jun 1988). In *Proceedings of the 9. International seminar on high energy physics problems. V. 1.* Order Number DE90706115. Available from NTIS (US Sales Only), PC A20/MF A01; OSTI; INIS.

Review of the main experimental results on ($K^{\pm}$, $\pi^{\pm}$, p, p-bar) hadron production with large transverse momenta in hadron-nuclear collisions is presented. Single production of charged hadrons with large P_T in interactions of protons and π^- with (D, Be, Ti, W, Cu, Pb) nuclei at 200-400 GeV energies as well as production of hadron pairs with large P_T ($\pi^0\pi^0$, $\pi^+\pi^+$, π^+p, pp, $k^+\pi$+, k^+p) and jets in pA collisions within 70-800 GeV range are considered. Expermental results for production cross sections of the investigated hadrons, their A dependences of hadron production inclusive cross sections, dependences of nuclear gain factor on A mass number and on P_T fixed values, nuclear enhancement of hadron inclusive spectra are analyzed in terms of hadron hard production models and modern quark-parton models. Analysis shows that main regularities of the investigated processes are qualitatively described by quark-parton models, while nuclear enhancement of hadron inclusive spectra results from rescattering and probably from parton emission in nuclear matter. 35 refs.; 16 figs.

41845 (JINR-D–1,2-88-652/v.1, pp. 258-266) **Energy and A-dependences of production cross sections of cumulative pions in proton-nuclear interactions at energy from 17 to 62 GeV.** Belyaev, N.M. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow (USSR). Inst. Teoreticheskoj i Ehksperimental'noj Fiziki); Gavrishchuk, O.P.; Zolin, L.S.; Peresedov, V.F. Joint Inst. for Nuclear Research, Dubna (USSR). 1988. (In Russian). (CONF-8806225–: 9. international seminar on high energy physics problems relativistic nuclear physics and quantum chromodynamics, Dubna (USSR), 14-19 Jun 1988). In *Proceedings of the 9. International seminar on high energy physics problems. V. 1.* Order Number DE90706115. Available from NTIS (US Sales Only), PC A20/MF A01; OSTI; INIS.

Energy and A dependences of production cross sections for cumulative π^- and π^+-mesons in p+Al → π^-+x, p+c → $\pi^{\pm}$+x reactions at primary proton energy range from 17 to 62 GeV were investigated. Invariant cross sections (ICS) of π^+ and π^--meson production by 17 and 57 GeV energy protons at $\pi^{\pm}$-meson different momenta, dependences of spectra temperature (and their slope) on primary proton energy are presented. A dependence of ICS under the conditions of pion cumulative production at different values of x cumulative variable, dependence of the effective thickness of nucleus passive layer and of hadron formation length on x are shown. Conclusion is made that the observed A dependence may be explained by means of certain assumption in terms of model which links cumulative effect with presence of multiquark systems or quark clusters in nucleus. 15 refs.; 10 figs.

41846 (JINR-D–1,2-88-652/v.1, pp. 267-270) **Study on a polarization of cumulative protons in proton-nuclear interactions at energy from 17 to 62 GeV.** Belyaev, I.M. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow (USSR). Inst. Teoreticheskoj i Ehksperimental'noj Fiziki); Vlasov, N.V.; Gavrishchuk, O.P.; Zolin, L.S.; Peresedov, V.F. Joint Inst. for Nuclear Research, Dubna (USSR). 1988. (In Russian). (CONF-8806225–:). In *Proceedings of the 9. International seminar on high energy physics problems. V. 1.* Order Number DE90706115. Available from NTIS (US Sales Only), PC A20/MF A01; OSTI; INIS.

Measurement results of cumulative proton polarization at 158 deg and 95 deg angles in p+^{12}C → p_c+x reaction at primary proton energy ranged from 17 up to 62 GeV are presented. Experiment was conducted using U-70 accelerator by means of polarimeter where drift chambers were used as trace detectors. Measured values of polarization at 95 deg and 158 deg angles for different ranges of E_0 primary proton energy as well as their energy dependences on E_0 are shown graphically. Conclusion is made that at angles close to 90 deg polarization of cumulative protons in carbon nucleus reaction within wide range of primary proton energy differs from zero and occurs at 10% level. 7 refs.; 7 figs.

41847 (JINR-D–1,2-88-652/v.1, pp. 279-285) **Characteristics of secondary particles produced in π^-C interactions at 40 GeV/c as a function of full energy and QCD of semihard process.** Baatar, Ts. (AN MNR, Ulan-Bator. Inst. Fiziki i Tekhniki (USSR)). Joint Inst. for Nuclear Research, Dubna (USSR). 1988. (In Russian). (CONF-8806225–: 9. international seminar on high energy physics problems relativistic nuclear physics and quantum chromodynamics, Dubna (USSR), 14-19 Jun 1988). In *Proceedings of the 9. International seminar on high energy physics problems. V. 1.* Order Number DE90706115. Available from NTIS (US Sales Only), PC A20/MF A01; OSTI; INIS.

Dependences of mean values of multiplicity and transverse momenta of secondary $\pi^{\pm}$-mesons produced in π^-C interactions at 40 GeV/c on full energy are investigated. Experimental data are obtained by means of two-meter propane bubble chamber irradiated by π^--meson beam with 40 GeV/c momentum. Distributions by squares of transverse momenta of secondary $\pi^{\pm}$ mesons from π^-C interactions for two different intervals of full energy in terms of center-of-mass system - $W \leq 4.36$ GeV and $17.4 \leq W \leq 24.6$ GeV - are presented. It is concluded that energy dependences of mean multiplicities and mean values of transverse momenta (or squares of transverse momenta) for $\pi^{\pm}$- mesons produced in π^-C interactions at 40 GeV/c and for secondary charged particles produced in e^+e^--annihilations at high energies are described well by exponential functions predicted by semihard process QCD. Essential broadening of distribution by squares of transverse momenta of secondary $\pi^{\pm}$-mesons from π^-C interactions are observed at the increase of W_{π^-C} energy. 7 refs.; 4 figs.; 3 tabs.

41848 (JINR-D–1,2-88-652/v.1, pp. 286-299) **Automodelity properties of multiple particle processes in hadron-hadron, hadron-nucleus and nucleus-nucleus interactions within an interval of 4-205 GeV/c.** Baldin, A.M.; Didenko, V.G.; Grishin, V.G.; Kuznetsov, A.A. Joint Inst. for Nuclear Research, Dubna (USSR). 1988. (CONF-8806225–: 9. international seminar on high energy physics problems relativistic nuclear physics and quantum chromodynamics, Dubna (USSR), 14-19 Jun 1988). In *Proceedings of the 9. International seminar on high energy physics problems. V. 1.* Order Number DE90706115. Available from NTIS (US Sales Only), PC A20/MF A01; OSTI; INIS.

Properties of hadron jets and baryon clusters in hadron multiple production in hadron-hadron, hadron-nucleus and nucleus-nucleus interactions within 4-205 GeV transferred momenta were investigated. Experimental data, obtained in different laboratories all over the world, for different selection techniques of hadron jets in p-barp-, pp-, π^-p-soft collisions, hadron-nucleus (pC, π^-C, pTa) and ν-barN-interactions within the whole energy region were considered. Experimental data were analyzed on the basis of automodelity principle and correlation degeneration. The obtained results linked with investigation of universality of properties of hadron jets in soft and hard hadron-hadron, hadron-nucleus collisions and properties of baryon clusters produced in hadron-nucleus and nucleus-nucleus collisions prove the validity of main conclusions of correlation degeneration and automodelity principles. 21 refs.; 12 figs.

41849 (JINR-D–1,2-88-652/v.1, pp. 317-327) **Status of narrow multibaryonic resonances studies.** Tatischeff, B. (Paris-11 Univ., 91 - Orsay (France). Inst. de Physique Nucleaire); Willis, N.; Comets, M.P.; Bornec, Y.L. Joint Inst. for Nuclear Research, Dubna (USSR). 1988. (CONF-8806225–: 9. international seminar on high energy physics problems relativistic nuclear physics and quantum chromodynamics, Dubna (USSR), 14-19 Jun 1988). In *Proceedings of the 9. International seminar on high energy physics problems. V. 1.* Order Number DE90706115. Available from NTIS (US Sales Only), PC A20/MF A01; OSTI; INIS.

Review of experimental conditions of observation of narrow dibaryon and tribaryon resonances in ^{3}He(p,d)x; p(^{3}He, d)x; p(p-vector, d)π^+; p(p,p)p; p(d, pπ)x; d(d,d)x; d(p-vector,π^-)x; d(p-vector,π^-)x; cc → ppp+x; π^-c → pppx; AC → pppx (A=p, d, ^{4}He) reactions is presented. Experimental data on measurement of mass spectra, isospins, structures and widths of dibaryons and tribaryons conducted in different laboratories of the world are analyzed and presented in the form of tables. Analysis of data of investigated dibaryon and tribaryon systems was conducted within the frameworks of cloudy bag models, nonrelativistic quark model, semiphenomenological diquarks cluster model. Perspective experiments, which prove the existence of dibaryons and tribaryons are discussed. 43 refs.; 7 figs.; 2 tabs.

41850 (JINR-D–1,2-88-652/v.1, pp. 328-336) **Narrow diproton resonances in the np → ppπ^- reaction.** Troyan, Yu.A. (Joint Inst. for Nuclear Research, Dubna (USSR)); Nikitin, A.V.; Pechenov, V.N. Joint Inst. for Nuclear Research, Dubna (USSR). 1988. (In Russian). (CONF-8806225–:). In *Proceedings of the 9. International seminar on high energy physics problems. V. 1.* Order Number DE90706115. Available from NTIS (US Sales Only), PC A20/MF A01; OSTI; INIS.

Distributions of effective masses of two protons from np → ppπ^- reaction at P_n=1.25; 1.43; 1.72 and 2.23 GeV/c (19 thousands of events in all) are presented. Data are obtained using one-meter hydrogen chamber irradiated by monochromatic neutrons ($\Delta P_n/P_n \approx 3\%$) from synchrophasotron. 16 diproton resonances with 1 MeV/c^2 true widths are determined with rather high certainty. Resonance contribution constitutes about 10% at each energy. Range of effective masses from 1876 to ≈ 2300 MeV/c^2 is investigated. Resonance effects occur within the whole region. Nature of new physical phenomena and hypothesis which explain production of narrow diproton resonances is discussed. 20 refs.; 6 figs.; 2 tabs.

41851 (JINR-D–1,2-88-652/v.1, pp. 337-343) **Multiquark bound and resonant states.** Shakhbazyan, B.A. (Joint Inst. for Nuclear Research, Dubna (USSR)); Sashin, V.A.; Martynov, A.S.; Gusev, A.V.; Kechechyan, A.O. Joint Inst. for Nuclear Research, Dubna (USSR). 1988. (CONF-8806225–:). In *Proceedings of the 9. International seminar on high energy physics problems. V. 1.* Order Number DE90706115. Available from NTIS (US Sales Only), PC A20/MF A01; OSTI; INIS.

Bound multiquark states with Y hypercharge within Y=2-5 range are investigated. Investigations were conducted in n^{12}C- and π^-^{12}C reactions at 7 and 4 GeV/c, respectively. Spectra of invariant masses for production of Λmp bound states where m=2-4 and of K^0 up, where n=1-5 are considered. Q^6 multiquark resonance states with Y ≤ 1 hypercharge, observation of which is possible in Λp(I=1/2, Y=1, B=2, S=-1) elastic scattering channel as well as in Λpπ(I=3/2; 1/2, Y=1, B=2, S=-1), $\Lambda\Lambda$(I=0, Y=0, B=2, S=2), $\Lambda\Lambda$p(I=1/2, Y=1, B=3, S=-2) systems and in H(I=0, Y=0, J=0$^+$) → Σ^-p dibaryon weak decay. Mass spectra of $\Lambda\Lambda$-, Λp systems are shown. Data for masses, widths, significances and cross sections of Λp production (on ^{12}C) and $\Lambda\pi^+\pi^+$ states in comparison with predicted data of bag model are presented in the tables. 21 refs.; 4 figs.; 2 tabs.

41852 (JINR-D–1,2-88-652/v.1, pp. 344-351) **Search for the narrow dibaryon resonances.** Vorob'ev, L.S. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow (USSR). Inst. Teoreticheskoj i Ehksperimental'noj Fiziki); Gavrilov, V.B.; Goryainov, N.A. Joint Inst. for Nuclear Research, Dubna (USSR). 1988. (In Russian). (CONF-8806225–:). In *Proceedings of the 9. International seminar on high energy physics problems. V. 1.* Order Number DE90706115. Available from NTIS (US Sales Only), PC A20/MF A01; OSTI; INIS.

Special experiment using electron technique was conducted to acquire statistically proved data on production of narrow diproton resonances (NDR) in pA(A=C, Cu, Pb) interactions at 7.5 GeV/c in the ITEP. Data on e$^\pm$ interactions with residual gas (N and O nuclei) from ARGUS detector which are compared with the obtained ones were used to investigate production of NDR within wide region of escape angles. Diagrams of two-proton distribution and resolution by effective mass are presented for pC- and e(N,O)- interactions as well as restrictions of NDR production probability in inelastic pC-, pPb- and e(N,O)-interactions. Peculiarities of the observed proton pairs in effective mass distributions are discussed. After the conducted experiments the authors believe that convincing evidences about existence of NDR in 1.9-2.2 GeV/c mass range are not found. 11 refs.; 7 figs.

41853 (JINR-D–1,2-88-652/v.1, pp. 352-357) **Observation of narrow diproton states in the ppγ-mode.** Budagov, Yu.A. (Joint Inst. for Nuclear Research, Dubna (USSR)); Lomakin, Yu.F.; Flyagin, V.B.; Kharzheev, Yu.N.; Abdinov, O.B.; Bayramov, A.A.; Mailov, A.A. Joint Inst. for Nuclear Research, Dubna (USSR). 1988. (CONF-8806225–:). In *Proceedings of the 9. International seminar on high energy physics problems. V. 1.* Order Number DE90706115. Available from NTIS (US Sales Only), PC A20/MF A01; OSTI; INIS.

Possible candidates for ppγ mode of dibaryon states and correlations between pp- and ppγ channels of their decay are investigated. Data were obtained by means of analysis of photoes made in one-meter bubble chamber of the Laboratory of Nuclear Researches exposed to 5 GeV/c negative pion beam. About 15000 pion-carbon interactions (propane target) and 7500 pion-nucleus ones (propane-freon target) with visible images of inelastic nuclear interactions were determined. Effective mass distributions of ppγ events for proton interactions with more than 270 MeV/c momentum are obtained. Structure expansion (narrow maxima) occuring near ≈ 1885 and ≈ 1915 MeV are observed in distribution of pp events by effective mass. Evaluation of cross sections for production of these states corresponds to σ=1.73±0.37 mb value. It is concluded that candidates for narrow diproton states decaying by ppγ mode with a great degree of certainty are observed. Data indicating existence of radiative transitions between different diproton states are obtained as well. 21 refs.; 3 figs.; 1 tab.

41854 (JINR-E–1-89-345) **Inclusive production of Φ-mesons in neutron-proton interactions at 30-70 GeV.** Aleev, A.N. (and others); Aref'ev, V.A.; Balandin, V.P. BIS-2 Collaboration. Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy. 1989. 10p. Order Number DE90632487. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

A signal of decays $\Phi \rightarrow K^+K^-$ has been observed in neutron-hydrogen interactions at energies 30-70 GeV in a experiment using the BIS-2 spectrometer. The longitudinal momentum spectrum in the forward region of Feynman variable $x_F>0.1$ at $P_T<1$ GeV/c can be well described by a power law dependence $(1-x_F)^N$ with N=4.28±0.42. The p_T^2-spectrum was parametrized by the exponent $\exp(-3.02xp_T^2)$ The extrapolation of the measured cross section to the full kinematic region yields a value of 220±85 μb. 15 refs.; 7 figs.; 1 tab.

41855 (JINR-R–1-89-332) **Two possibilities provided by UNK for studying CP-invariance violation in B-meson decays.** Govorkov, B.B. (AN SSSR, Moscow (USSR). Fizicheskij Inst.); Zajmidoroga, O.A. Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems; AN SSSR, Moscow (USSR). Fizicheskij Inst. 1989. 11p. (In Russian). Order Number DE90632488. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Submitted to the Organizing Committee of the Intern. Conf. Physics on the Sepukhov Tevatron, Protvino, March, 1989.

Two possibilities provided by the UNK for studying CP-invariance violation in rare decays of B mesons have been considered. The first one - the use as a source of B-mesons -the photoproduction of bb-bar-pair of quarks on the fixed target of UNK due to better $\sigma_{bbbar}/\sigma_{tot}$ ratio of pair quark production to total cross section and smaller multiplicity of particle than in hadroproduction. The second - the use of colliding pp beams with inequal energies of beams which allows to utilize the narrow aperture set up in pp-bar collider experiment. 27 refs.; 3 figs.; 2 tabs.

41856 (KFKI–1990-07/A) **Inclusive Ξ^- and anti-Ξ^+ production in 360 GeV/c pp interactions using the European Hybrid Spectrometer.** Gemesy, T.; Hidas, P.; Pinter, G. Hungarian Academy of Sciences, Budapest (Hungary). Central Research Inst. for Physics. Feb 1990. 12p. Order Number DE90632489. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The study of the s=±2 hyperons gives information about the production of strange quarks during fragmentation. The Lund model

describing the strange quark production mechanisms can be tested by measuring the inclusive parameters. The data of the European Hybrid Spectrometer were used to determine cross sections, momentum, x_F and p_T distributions for inclusive Ξ^- and anti-Ξ^+ hyperon production in 360 GeV/c proton-proton interactions. Total inclusive cross sections and Ξ/Λ production ratio are presented. Two main decay modes were studied. Ω^- production was not detected. (D.G.) 14 refs.

41857 (LA–11877-C, pp. 1-12) **The nucleon-nucleon interaction in the presence of the electromagnetic field: Nucleon-nucleon bremsstrahlung.** Brown, V.R. Los Alamos National Lab., NM (USA). Jul 1990. (CONF-900179–Summs: Los Alamos National Laboratory (LANL) workshop on n-p Bremsstrahlung, Los Alamos, NM (USA), 25-26 Jan 1990). In *Lectures from the workshop on nucleon-nucleon bremsstrahlung, January 25-26, 1990.* Order Number DE90012740. Available from NTIS, PC A95/MF A01.

Nucleon-nucleon bremsstrahlung, NNγ, is a fundamental process, which involves the strong and electromagnetic fields acting simultaneously. Since the electromagnetic interaction is well known, NNγ provides a calculable tool for comparing off-energy-shell effects from different two-nucleon potentials compared to experiment and also provides a simple testing ground, which is sensitive to meson-exchange-current contributions that are so important in electronuclear physics. Historically, experimental studies have focused on ppγ, with only a few measurements of npγ. The present workshop was organized primarily to investigate the interest in, the value of, and the feasibility of doing an npγ experiment using the neutron white source at LANL. An increasing amount of US nuclear physics dollars are being spent on electronuclear physics. npγ is a fundamental process with large meson-exchange currents. In the npγ calculations of Brown and Franklin, the meson-exchange contributions increase the cross section by a factor of roughly two and later the angular distribution of the emitted photon dramatically. The details of these calculated effects have never been verified experimentally, but the proper quantum-mechanical inclusion of meson-exchange contributions, using the methods of brown and Franklin, has proved to be essential in understanding the heavy-ion results. The understanding of the importance of such terms is extremely important inelectronuclear processes, such as are presently under investigation or being planned at Bates, SLAC, and CEBAF. Just one example is in the electrodisintegration of the deuteron, where meson-exchange contributions must be included properly before any conclusions about nuclear models, such as QCD versus meson-exchange potentials can be made.

41858 (LA–11877-C, pp. 13-26) **Nucleon-nucleon bremsstrahlung experiments.** Brady, F.P. (Univ. of California, Davis (USA)). Los Alamos National Lab., NM (USA). Jul 1990. (CONF-900179–Summs: Los Alamos National Laboratory (LANL) workshop on n-p Bremsstrahlung, Los Alamos, NM (USA), 25-26 Jan 1990). In *Lectures from the workshop on nucleon-nucleon bremsstrahlung, January 25-26, 1990.* Order Number DE90012740. Available from NTIS, PC A95/MF A01.

Nucleon-nucleon bremsstrahlung experiments and data are reviewed. The emphasis is on neutron-proton bremsstrahlung. Experimental problems are examined with a view to possible improvements in contemplated experiments at LANL. Nucleon-nucleon bremsstrahlung remains a difficult challenge for both experimentalists and theorists. In ppγ, the off-shell effects of the different NN models is comparable to the uncertainties in most of the data. In npγ, the cross sections are larger but the experiments are more difficult to carry out with precision. However it does seem worthwhile to investigate further both the model predictions and possible npγ experiments. A very positive factor is the considerable improvement over the past 20 years in apparatus and facilities and in data capture and analysis techniques. The support of the National Science Foundation, and helpful discussions with Virginia Brown, Harold Fearing, Gordon Greeniaus, and Juan Romero in preparing this report are gratefully acknowledged. 27 refs., 5 figs.

41859 (LA–11877-C, pp. 27-44) **Proton-proton bremsstrahlung: What has been learned?.** Fearing, H.W. (TRIUMF, Vancouver (Canada)). Los Alamos National Lab., NM (USA). Jul 1990. (CONF-900179–Summs: Los Alamos National Laboratory (LANL) workshop on n-p Bremsstrahlung, Los Alamos, NM (USA), 25-26 Jan 1990). In *Lectures from the workshop on nucleon-nucleon bremsstrahlung, January 25-26, 1990.* Order Number DE90012740. Available from NTIS, PC A95/MF A01.

The author summarizes some of the information about the nucleon-nucleon force which has been obtained by comparing recent calculations of proton-proton bremsstrahlung with cross section and analyzing power data from the new TRIUMF bremsstrahlung experiment. A recent potential model calculation of the process is described. Some of the specific things which have been learned, or not learned, are discussed. Finally comments are made as to how these results can be extended to neutron-proton bremsstrahlung. 17 refs., 6 figs.

41860 (LA–11877-C, pp. 45-49) **n-p-γ bremsstrahlung below 210 MeV bombarding energy.** Pinston, J.A. (Institut des Sciences Nucleaire, Grenoble (France)); Nifenecker, H. Los Alamos National Lab., NM (USA). Jul 1990. (CONF-900179–Summs: Los Alamos National Laboratory (LANL) workshop on n-p Bremsstrahlung, Los Alamos, NM (USA), 25-26 Jan 1990). In *Lectures from the workshop on nucleon-nucleon bremsstrahlung, January 25-26, 1990.* Order Number DE90012740. Available from NTIS, PC A95/MF A01.

The author experimental knowledge of the nucleon-nucleon-gamma production is irregular. The proton-proton system has been thoroughly studied, since it is the simplest, experimentally. In this case, a good measurement of the momenta and energies of the two protons, after scattering, is basically sufficient to describe the reaction. The neutron-neutron system is unknown, for obvious reasons. The knowledge of the neutron-proton-gamma process is poor. This is due to the small intensity and bad resolution of the neutron beams. Furthermore the neutron and photon detectors are more difficult to build and less performing than proton detectors. The author concentrate, in the following, on the n-p-γ reaction. 15 refs., 3 figs., 1 tab.

41861 (LA–11877-C, pp. 51-58) **Soft-proton approach to neutron-proton bremsstrahlung.** Liou, M.K. (City Univ. of New York, Brooklyn (USA)). Los Alamos National Lab., NM (USA). Jul 1990. (CONF-900179–Summs: Los Alamos National Laboratory (LANL) workshop on n-p Bremsstrahlung, Los Alamos, NM (USA), 25-26 Jan 1990). In *Lectures from the workshop on nucleon-nucleon bremsstrahlung, January 25-26, 1990.* Order Number DE90012740. Available from NTIS, PC A95/MF A01.

There are many good reasons for measuring the neutron-proton bremsstrahlung cross sections at intermediate energies: (1) The neutron-proton bremsstrahlung, like the proton-proton bremsstrahlung, is an ideal process for investigating the off-shell behavior of the two-nucleon interaction. (2) The measured neutron-proton bremsstrahlung cross sections can be used to distinguish various phenomenological potentials. (3) The measured neutron-proton bremsstrahlung spectra in the hard-photon regions at intermediate energies can be used to study the problem of the high-energy photon emission in heavy ion collisions. (4) The measured neutron-proton bremsstrahlung cross sections at intermediate energies can be used to test the range of validity of various theoretical models and approximations. 14 refs.

41862 (LA–11877-C, pp. 67-74) **Possibilities for a neutron-proton bremsstrahlung experiment at WNR/LAMPF.** Wender, S.A. (Los Alamos National Lab., NM (USA)); Nelson, R.O.; Laymon, C.M.; Schillaci, M.; Gibson, B.F. Los Alamos National Lab., NM (USA). Jul 1990. (CONF-900179–Summs: Los Alamos National Laboratory (LANL) workshop on n-p Bremsstrahlung, Los Alamos, NM (USA), 25-26 Jan 1990). In *Lectures from the workshop on nucleon-nucleon bremsstrahlung, January 25-26, 1990.* Order Number DE90012740. Available from NTIS, PC A95/MF A01.

The high energy and high intensity of the continuous energy (white) neutron source at the WNR target area of the Los Alamos Meson Physics Facility (LAMPF) may make possible a direct measurement of the neutron-proton bremsstrahlung (NPB) cross section. Several recent papers have discussed the operation of the WNR white neutron source in detail so we will just include a short description of the relevant properties of the source in this article. Next the authors will describe one possible method of measuring the NPB cross section which is based on two calorimetric detectors

that measure the energies of the scattered neutrons and the recoil protons. Although there are many other possible experimental approaches and geometries, such as measuring the bremsstrahlung gamma ray directly with a multi-element possibilities in this paper. There are several advantages in using a white neutron source for this type of measurement. First, a wide range of incident neutron energies may be covered. In the case of the WNR, the energy range is from below 50 MeV to over 400 MeV which is above the pion production threshold. Second, all incident neutron energies are measure simultaneously. 6 refs., 5 figs.

41863 (LA–11877-C, pp. 75-91) **Nucleon-nucleon bremsstrahlung.** Macfarlane, M.H. Los Alamos National Lab., NM (USA). Jul 1990. (CONF-900179–Summs: Los Alamos National Laboratory (LANL) workshop on n-p Bremsstrahlung, Los Alamos, NM (USA), 25-26 Jan 1990). In *Lectures from the workshop on nucleon-nucleon bremsstrahlung, January 25-26, 1990.* Order Number DE90012740. Available from NTIS, PC A95/MF A01.

This workshop summarized the current state of nucleon-nucleon bremsstrahlung (NNB) experiments and their theoretical interpretation and identified the physics accessible to new, more accurate and more systematic experiments. It was designed to help with the planning of neutron-proton bremsstrahlung experiments at LAMPF using the existing intense white neutron source. The white neutron source provides the unique opportunity for high precision studies of np bremsstrahlung below and slightly above the pion threshold. The two nucleons and the photon final state should be detected in coincidence, nucleons near the forward direction, photons at 90 degrees or more in the laboratory. Such kinematics, with coplanar and non-coplanar geometry, favor studies of meson-exchange currents. This puts npB experiments in their proper context as part of a broad national program of studies of the electromagnetic properties of few-nucleon systems. 19 refs., 3 figs.

41864 (SSC–150) **DTUJET-87.** Ranft, J. Lawrence Berkeley Lab., CA (USA). SSC Central Design Group. 9 Dec 1987. 18p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-89ER40486. Order Number DE90014652. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

The dual topological unitarization of hard and soft hadronic cross sections is a new model of hadronic multi-particle production, which treats both soft (low $p_\perp$) and hard (minijet, large $p_\perp$) processes in a unified and consistent way. This description is important at the TeV-energies of hadron colliders, where the hard perturbative cross sections of QCD become large and comparable to the total cross sections. The code DTUJET samples Monte carlo events in pp and $\bar{p}p$ collisions according to this new model. 15 refs., 3 figs.

41865 Observation of $\Upsilon(4S)$ decays into non-$B\bar{B}$ final states containing ψ mesons. Alexander, J.; Artuso, M.; Bebek, C.; Berkelman, K.; Cassel, D.G.; Cheu, E.; Coffman, D.M.; Crawford, G.; DeWire, J.W.; Drell, P.S. *Physical Review Letters (USA),* 64(19): 2226-2229 (7 May 1990). DOE Contract AC02-83ER40105 ;FG05-86ER40272.

We report on the observation of ψ mesons from $\Upsilon(4S)$ decays which are too energetic to come from B mesons. These events provide the first evidence for non-$B\bar{B}$ decays of the $\Upsilon(4S)$. The measured rate is $B[\Upsilon(4s)\rightarrow\psi X]=(0.22\pm0.06\pm0.04)\%$ for ψ momentum above 2 GeV/c.

41866 Measurement of the total hadronic cross section in tagged $\gamma\gamma$ reactions. Aihara, H.; Alston-Garnjost, M.; Avery, R.E.; Barker, A.R.; Bauer, D.A.; Bay, A.; Belcinski, R.; Bingham, H.H.; Bloom, E.D.; Buchanan, C.D. TPC/Two-Gamma Collaboration. *Physical Review, D (Particles Fields) (USA),* 41(9): 2667-2674 (1 May 1990).

We present a measurement of the total cross section for $\gamma\gamma\rightarrow$hadrons, with one photon quasireal and the other a spacelike photon of mass squared $-Q^2$. Results are presented as a function of Q^2 and the $\gamma\gamma$ center-of-mass energy W, with the Q^2 range extending from 0.2 to 60 GeV^2, and W in the range from 2 to 10 GeV. The data were taken with the TPC/Two-Gamma facility at the SLAC e^+e^- storage ring PEP, which was operated at a beam energy of 14.5 GeV. The cross section exhibits a gentle falloff with increasing W. Its Q^2 dependence is shown to be well described by an incoherent sum of vector-meson and pointlike scattering over most of the observed W range. Agreement at high Q^2 is improved if a minimum-p_T cutoff (motivated by QCD) is imposed on the pointlike contribution.

41867 Study of $D_s^+\rightarrow\phi e^+\nu_e$ and the absolute $D_s^+\rightarrow\phi\pi^+$ branching fraction. Anjos, J.C.; Appel, J.A.; Bean, A.; Bracker, S.B.; Browder, T.E.; Cremaldi, L.M.; Duboscq, J.E.; Elliott, J.R.; Escobar, C.O.; Gibney, M.C. *Physical Review Letters (USA),* 64(24): 2885-2888 (11 Jun 1990).

We have searched for the decay $D_s^+\rightarrow\phi e^+\nu_e$ in data from the Fermilab charm photoproduction experiment E691. The resulting upper limit is $B(D_s^+\rightarrow\phi e^+\nu_e)<0.45B(D_s^+\rightarrow\phi\pi^+)$. Since the branching fraction for $D_s^+\rightarrow\phi e^+\nu_e$ can be calculated from the measured branching fraction $B(D^+\rightarrow\bar{K}^{*0}e^+\nu_e)$ to be $(1.7\pm0.3)\%$, this implies a 90%-confidence-level lower limit on $B(D_s^+\rightarrow\phi\pi^+)$ of 3.4%.

41868 Search for doubly charged Higgs scalars in Z decay. Swartz, M.; Abrams, G.S.; Adolphsen, C.E.; Averill, D.; Ballam, J.; Barish, B.C.; Barklow, T.; Barnett, B.A.; Bartelt, J.; Bethke, S. *Physical Review Letters (USA),* 64(24): 2877-2880 (11 Jun 1990). DOE Contract AC02-84ER40125 ;AC03-76SF00098 ;AC02-76ER01112 ;AC

We describe a search for the decay of the Z boson into pairs of doubly charged Higgs bosons with the Mark II detector operating at the SLAC Linear Collider. Each Higgs boson is assumed to decay into a same-sign leptonic pair. No event candidates are found in a sample of 528 Z decays. At the 95% confidence level, this result excludes the region of leptonic coupling $g_{ll}>3\times10^{-7}$ and Higgs-boson mass $6.5<M_H<36.5$ GeV/c^2 for isotriplet (left-handed) Higgs bosons. Isosinglet (right-handed) Higgs bosons are excluded in the same g_{ll} interval and in the mass interval $7.3<M_H<34.3$ GeV/c^2.

41869 Search for nonminimal neutral Higgs bosons from Z-boson decays. Komamiya, S.; Abrams, G.S.; Adolphsen, C.E.; Averill, D.; Ballam, J.; Barish, B.C.; Barklow, T.; Barnett, B.A.; Bartelt, J.; Bethke, S. *Physical Review Letters (USA),* 64(24): 2881-2884 (11 Jun 1990). DOE Contract AC03-76SF00098 ;AC02-84ER40125 ;AC03-76SF00515.

Using the Mark II detector at the SLAC Linear Collider, we search for decays of the Z boson to a pair of nonminimal Higgs bosons ($Z\rightarrow H_s^0H_p^0$), where one of them is relatively light ($\lesssim$10 GeV). We find no evidence for these decays and we obtain limits on the $ZH_s^0H_p^0$ coupling as a function of the Higgs-boson masses.

41870 Test of *CPT* symmetry through a determination of the difference in the phases of η_{00} and η_{+-} in $K\rightarrow2\pi$ decays. Karlsson, M. (Department of Physics, Princeton University, Princeton, NJ (USA)); Gollin, G.D.; Okamitsu, J.K.; Tschirhart, R.; Barker, A.; Briere, R.A.; Gibbons, L.K.; Makoff, G.; Papadimitriou, V.; Patterson, J.R. *Physical Review Letters (USA),* 64(25): 2976-2979 (18 Jun 1990).

Data collected by the E731 experiment at Fermilab were used to search for *CPT* violation in $K^0\rightarrow\pi\pi$ decays by measuring the difference $\Delta\phi$ between the phases of the *CP*-violating parameters η_{00} and η_{+-}. Our result, $\Delta\phi=-0.3^\circ\pm2.4^\circ\pm1.2^\circ$, where the first error is statistical and the second systematic, is consistent with *CPT* symmetry.

41871 Direct search for pair production of heavy stable charged particles in Z decays. Soderstrom, E.; McKenna, J.A.; Abrams, G.S.; Adolphsen, C.E.; Averill, D.; Ballam, J.; Barish, B.C.; Barklow, T.; Barnett, B.A.; Bartelt, J. *Physical Review Letters (USA),* 64(25): 2980-2983 (18 Jun 1990). DOE Contract AC03-83ER40103 ;AC02-84ER40125 ;AC03-76SF00098 ;AC

A search for pair production of stable charged particles from Z decay has been performed with the Mark II detector at the SLAC Linear Collider. Particle masses are determined from momentum, ionization energy loss, and time-of-flight measurements. A limit excluding pair production of stable fourth-generation charged leptons and stable mirror fermions with masses between the muon mass and 36.3 GeV/c^2 is set at the 95% confidence level. Pair production of stable supersymmetric scalar leptons with masses between the muon mass and 32.6 GeV/c^2 is also excluded.

41872 Searches for supersymmetric particles produced in Z-boson decay. Barklow, T.; Abrams, G.S.; Adolphsen, C.E.; Averill, D.; Ballam, J.; Barish, B.C.; Barnett, B.A.; Bartelt, J.;

Bethke, S.; Blockus, D. *Physical Review Letters (USA)*, 64(25): 2984-2987 (18 Jun 1990). DOE Contract AC03-76SF00098 ;AC02-84ER40125 ;AC03-76SF00515.

We have searched for supersymmetric particles in 528 Z decays with the Mark II detector at the SLAC Linear Collider. We place 95%-confidence-level lower mass limits on degenerate squarks, nondegenerate up-type squarks, nondegenerate down-type squarks, charginos, pair-produced unstable neutralinos, and neutralinos from associated production.

41873 Limits on the production of light scalar and pseudoscalar particles. Semertzidis, Y. (Department of Physics and Astronomy, University of Rochester, Rochester, NY (USA)); Cameron, R.; Cantatore, G.; Melissinos, A.C.; Rogers, J.; Halama, H.; Prodell, A.; Nezrick, F.; Rizzo, C.; Zavattini, E. *Physical Review Letters (USA)*, 64(25): 2988-2991 (18 Jun 1990). DOE Contract AC02-76ER13065 ;AC02-76CH00016.

We are searching for the coherent production of light pseudoscalar or scalar particles in a 12-m optical cavity placed in a 5-T transverse magnetic field. From the level of the observed optical rotation we have set a limit on the coupling of such particles to two photons, $g_{a\gamma\gamma}<2.5\times10^{-6}$ GeV^{-1}, provided $m_a\lesssim7\times10^{-4}$ eV.

41874 Determination of electroweak parameters from the elastic scattering of muon neutrinos and antineutrinos on electrons. Ahrens, L.A. (Physics Department, Brookhaven National Laboratory, Upton, NY (USA)); Aronson, S.H.; Connolly, P.L.; Gibbard, B.G.; Murtagh, M.J.; Murtagh, S.J.; Terada, S.; White, D.H.; Callas, J.L.; Cutts, D. *Physical Review, D (Particles Fields) (USA)*, 41(11): 3297-3316 (1 Jun 1990).

Total and differential cross sections for $\nu_\mu e\to\nu_\mu e$ and $\bar{\nu}_\mu e\to\bar{\nu}_\mu e$ are measured. Values for the model-independent neutral-current couplings of the electron are found to be $g_V=-0.107\pm0.035(\text{stat})\pm0.028(\text{syst})$ and $g_A=-0.514\pm0.023(\text{stat})\pm0.028(\text{syst})$. The electroweak mixing parameter $\sin^2\theta_W$ is determined to be $0.195\pm0.018(\text{stat})\pm0.013(\text{syst})$. Limits are set for the charge radius and magnetic moment of the neutrino as $\langle\langle r^2\rangle\rangle<0.24\times10^{-32}$ cm^2 and $f_\mu<0.85\times10^{-9}$ Bohr magnetons, respectively.

41875 Charge-exchange photoproduction of the $a_2^-(1320)$ in association with Δ^{++} at 19.3 GeV/c. Condo, G.T.; Handler, T.; Shimony, J.; Abe, K.; Austern, M.; Armenteros, R.; Bacon, T.C.; Ballam, J.; Bingham, H.H.; Brau, J.E. SLAC Hybrid Facility Photon Collaboration. *Physical Review, D (Particles Fields) (USA)*, 41(11): 3317-3323 (1 Jun 1990). DOE Contract AC03-76SF00515.

We examine the negative 3π final state produced in association with $\Delta^{++}(1232)$ in the reaction $\gamma p\to\Delta^{++}\pi^+\pi^-\pi^-$ at an incident photon energy of 19.3 GeV. The most prominent enhancement in the 3π spectrum occurs at a mass and with a width consistent with the parameters of the $a_2(1320)$. This identification is confirmed by the various angular distributions. The a_2 production cross section, corrected for efficiencies and alternate a_2 decay modes, is 0.45 ± 0.05 μb.

41876 Solar neutrino observations and neutrino oscillations. Kuo, T.K. (Physics Department, Purdue University, West Lafayette, Indiana 47907 (USA)); Pantaleone, J. *Physical Review, D (Particles Fields) (USA)*, 41(12): 3842-3845 (15 Jun 1990).

The results of recent Kamiokande-II and ^{37}Cl solar-neutrino experiments are quantitatively analyzed assuming the Mikheyev-Smirnov-Wolfenstein solution to the solar-neutrino problem. It is found that the parameter region known as the "large mass" solution to the solar-neutrino problem is disfavored by a little more than 1 σ while the "small mass" and "large angle" solutions are in good agreement at this level. The implications on this analysis from time variations in the data are discussed.

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Refer also to citation(s) 41441, 41829, 41876, 41969, 41972, 42028, 42029, 42030, 42035, 42048

41877 (IC–89/381) Single leptoquark and extra neutral gauge Z-boson on future e^+e^- colliders. Aliev, T.M.; Bayramov, A.A. International Centre for Theoretical Physics, Trieste (Italy). Dec 1989. 24p. Order Number DE90632208. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

We have studied the single scalar (fermion) leptoquark and Z-boson production in e^+e^- collision at $\sqrt{s}$ = 2 TeV (CLIC project) in the framework of the Weizsacker-Williams Approximation (WWA). It is shown that the cross-sections of their processes are large and quite detectable if the total luminosity is $L=10^{33}sm^{-2}sec^{-1}$ (if masses of new particles below 2 TeV). Exact analytical expressions for a visible electron spectrum for all cases are received. From investigations follows that the study of the visible electron energy spectrum is a very effective tool to determine the masses of the scalar and fermion leptoquarks and Z-boson. (author). 16 refs, 9 figs, 1 tab.

41878 (IC–90/38) On covariant quantization of massive superparticle with first class constraints. Huq, M. International Centre for Theoretical Physics, Trieste (Italy). Feb 1990. 12p. Order Number DE90632373. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

We use the technique of Batalin and Fradkin to convert the second class fermionic constraints of the massive superparticle into first class constraints. Then the Batalin-Vilkovisky formalism has been used to quantize covariantly the resulting theory. Appropriate gauge fixing conditions lead to a completely quadratic action. Some interesting properties of the physical space wave functions are discussed. (author). 16 refs.

41879 (IFVE-OTF–89-89) $D\to K^*e\nu$ decay in QCD sum rule method. Ovchinnikov, A.A. (AN SSSR, Moscow (USSR). Inst. Yadernykh Issledovanij); Slobodenyuk, V.A. Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Serpukhov (USSR). Inst. Fiziki Vysokikh Ehnergij. 1989. 11p. (In Russian). Order Number DE90632155. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Submitted to Z. Phys. C.

The form factors of the $D\to K^*e\nu$ are calculated by means of the QCD sum rules method for the three-point correlators. The decay width is obtained. Theoretical evaluation for the ratio of the decay rates into the channels $D\to K^*e\nu$ and $D\to Ke\nu$ (the last decay was explored in this approach by T.M. Aliev, V.L. Eletsky, and Ya.I. Kogan) is compared with the experimental values. There is an agreement with the experimental data within the theoretical and experimental uncertanties involved. 14 refs.

41880 (IFVE-OTF-NTL–89-141) Spin effects at high energies and transfer momenta in hadron reactions. Babaev, Z.R.; Shchelkachev, A.V. Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Serpukhov (USSR). Inst. Fiziki Vysokikh Ehnergij. 1989. 5p. (In Russian). Order Number DE90632227. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

The possibilities of experimental observation of the consequences of QCD-vacuum fluctuations in the form of the spin effects in hadronic reactions are discussed. 6 refs.

41881 (INP–1358/PH) Small x physics in QCD, minijets and unitarity. Kwiecinski, J. Institute of Nuclear Physics, Cracow (Poland). 1987. 12p. (CONF-870339–: Moriond meeting on hadrons, quarks and gluons, Les Arcs (France), 15-21 Mar 1987). Order Number DE90632283. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Semihard interactions such as gluon minijet production in hadronic collisions are discussed taking into account recent results concerning the small x limit of gluon distributions in perturbative QCD and unitarity effects. Estimate of the cross-section for minijet production and its energy dependence are presented and the total effect of semihard interactions on inelastic cross-section is discussed. Simple results obtained by incorporating the semihard interactions within the dual parton model for multiparticle production are also presented. 17 refs., 2 figs. (author).

41882 (INP–1367/PL) Nucleon in confining models with glueballs. Broniowski, W. Institute of Nuclear Physics, Cracow (Poland). Jul 1987. 7p. (CONF-8706416–: Workshop on mesonic degrees of freedom in hadrons, Bled-Ljubljana (Yugoslavia), 28

Jun 1987). Order Number DE90632284. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

Solutions to non-chiral and chiral color dielectric models are discussed. The coupling of glueballs produces absolute quark confinement and generates selfconsistently a bag. 9 refs., 2 figs., 1 tab. (author).

41883 (INS–807) **Atmospheric neutrino fluxes.** Honda, M. (Tokyo Univ., Tanashi (Japan). Inst. for Cosmic Ray Research); Kasahara, K.; Hidaka, K.; Midorikawa, S. Tokyo Univ., Tanashi (Japan). Inst. for Nuclear Study. Feb 1990. 15p. Order Number DE90508023. Available from NTIS (US Sales Only), PC A03/MF A01.

A detailed Monte Carlo simulation of neutrino fluxes of atmospheric origin is made taking into account the muon polarization effect on neutrinos from muon decay. We calculate the fluxes with energies above 3 MeV for future experiments. There still remains a significant discrepancy between the calculated (ν_e+antiν_e)/(ν_μ+antiν_μ) ratio and that observed by the Kamiokande group. However, the ratio evaluated at the Frejus site shows a good agreement with the data. (author).

41884 (INS-T–493) **Workshop on low-dimensional quantum field theory and its applications: Collected transparencies of the talks.** Yamamoto, Hisashi (ed.). Tokyo Univ., Tanashi (Japan). Inst. for Nuclear Study. Feb 1990. 326p. (In Japanese, English). (CONF-8912106–: Workshop on low-dimensional quantum field theory and its applications, Tanashi (Japan), 18-20 Dec 1989). Order Number DE90508071. Available from NTIS (US Sales Only), PC A15/MF A01.

The workshop on 'Low-Dimensional Quantum Field Theory and its Applications' was held at INS on December 18 - 20, 1989 with about seventy participants. Some pedagogical reviews and the latest results were delivered on the recent topics related to both solid-state and particle physics. Among them are quantum Hall effect, high T_c superconductivity and related topics in low-dimensional quantum field theory. Many active discussions were made on these issues. (J.P.N.).

41885 (ITEF–55-89) **Calculation of effective Lagrangian in σ model of vector, pseudoscalar mesons and dilaton.** Ksenzov, V.G. Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow (USSR). Inst. Teoreticheskoj i Ehksperimental'noj Fiziki. 1989. 16p. (In Russian). Order Number DE90632285. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Method for calculating effective Lagrangian of vector and pseudoscalar mesons and dilaton was considered in σ model. Meson masses were determined. 18 refs.

41886 (ITEF–67-89) **Interference of identical pions produced in π^+p interactions at 4.5 GeV/c.** Andryakov, A.D.; Vojtenko, I.D.; Trebukhovskij, Yu.V. Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow (USSR). Inst. Teoreticheskoj i Ehksperimental'noj Fiziki. 1989. 11p. (In Russian). Order Number DE90632286. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The paper deals with investigations of interference correltions of pairs of identical charged π mesons in 4- and 6-radiation events of π^+p-interactions at 4.5 GeV/c momentum. Estimations of the spatial parameter of the pion emission region were obtained. They don't differ for 4- and 6-radiation interactions within the limits of experimental errors. Investigation into configuration of pion generation region was conducted. It doesn't differ from sphere within the limits experimental values. It is shown that resonances do not effect pion interference from the viewpoint of existence of two regions of pion generation with different characteristic sizes. 14 refs.; 4 tabs.

41887 (ITEF–80-89) **Baryon exchange binary reactions.** Zhokin, A.S.; Leksin, G.A.; Stolin, V.L.; Khasanov, F.M. Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow (USSR). Inst. Teoreticheskoj i Ehksperimental'noj Fiziki. 1989. 20p. (In Russian). Order Number DE90632287. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Data on the reaction of associated production of Δ and f_2 resonances in π^++p→Δ^{++}+f_2^0 baryon exchange reaction at 3.94 GeV/c momentum are presented. Some general experimental regularities of binary reactions of baryon exchange induced by incident pions are considered. 44 refs.; 4 figs.

41888 (ITEF–81-89) **Approximation of antiproton spectra in pp- and pA collisions.** Demidova, E.V.; Sibirtsev, A.A. Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow (USSR). Inst. Teoreticheskoj i Ehksperimental'noj Fiziki. 1989. 12p. (In Russian). Order Number DE90632288. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Phenomenological expressions, describing the inclusive cross sections of antiproton production in proton-proton and proton-nucleus collisions in *O-100 GeV energy range were obtained. 12 refs.; 10 figs.

41889 (ITEF–90-89) **Planar experiment as possible method of QCD tube investigation.** Levintov, I.I. Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow (USSR). Inst. Teoreticheskoj i Ehksperimental'noj Fiziki. 1989. 15p. (In Russian). Order Number DE90632289. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

It is proposed to distinguish the plane events with Δq_{tr}/q-bar$_{tr}$<<1 in the narrow region of transverse momenta in processes of nultiple hadron production in soft hdron-hadron interactions. Probablity of formation of such events, depending on multiplicity of charged particles (n) and Δq_{tr}/q-bar$_{tr}$ at azimuth-independent distribution of transverse momenta in the phase volume was calculated. The arguments, owing to which the probability of plane event observation grows sufficiently at fragmentation of isolated QCD strings, are presented. Probability of formation of plane events, conditioned by isolated QCD string fragmentation, decreases with momentum as $\approx P_{lab}^{-1/2}$. 6 refs.; 1 fig.

41890 (ITEP–65-89) **Baryon Regge trajectories from the area-law of Wilson loop.** Simonov, Yu.A. Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow (USSR). Inst. Teoreticheskoj i Ehksperimental'noj Fiziki. 1989. 16p. Order Number DE90632291. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

In the proper-time path integral representation of the three-quark Green function, baryon masses are calculated for large angular momenta L. Dynamics is given by vacuum background fields in the Wilson loop. Assuming an area law for large Wilson loops one obtains linear baryon Regge trajectories with the same slope as for mesons. For large L the baryon has an asymmetric structure of the quark-diquark type. Dynamic masses of the quark and diquark are generated, which grow with L. 8 refs.

41891 (ITEP–97-89) **Spin interactions of light quarks.** Simonov, Yu.A. Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow (USSR). Inst. Teoreticheskoj i Ehksperimental'noj Fiziki. 1989. 24p. Order Number DE90632292. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Spin-spin and spin-orbit interactions of light quarks is calculated exactly, i.e. without use of perturbation expansion in $(\text{mass})^{-1}$. Vacuum gluonic fields are represented by bilocal correlators $\langle F(x)F(y)\rangle$ and higher order correlators are neglected. Perturbative contribution is reproduced in lowest order by a simple modification of the bilocal correlator, and the smearing of the function in the hyperfine term is discussed. 12 refs.

41892 (ITEP–105-89) **A new mechanism for NN-bar annihilation into three mesons in the constituent quark model.** Kalashnikova, Yu.S.; Yurov, V.P. Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow (USSR). Inst. Teoreticheskoj i Ehksperimental'noj Fiziki. 1989. 14p. Order Number DE90632290. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The S-wave NN scattering is studied in assumption of rearrangement into three-mesons via 3q3q-bar confined states. The quark potential model is used for calculation of transition amplitudes NN-anti→3q3q-bar and 3M→3q3q-bar. It is shown that the data on cross sections are described satisfactorily and threshold behaviour of amplitudes is reproduced. 12 refs.; 2 figs.

41893 (ITF–87-120) **Asymptotic behaviour of total effective interquark potential cross-sections and equations of state in a model of resonances with equidistant spectrum.** Bugrij, A.I.;

Trushevskij, A.A.; Shadura, V.N. AN Ukrainskoj SSR, Kiev (Ukrainian SSR). Inst. Teoreticheskoj Fiziki. 1987. 9p. (In Russian). Order Number DE90632293. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

A phenomenological model, in which strong interaction is dependent on the effective exchange of narrow spinless resonances with the mass spectrum $m_k^2=k\mu^2$, k=1,2,3... is suggested. In this model the asymptotic cross-section of the nucleon-nucleon scattering is constant, the interquark potential is singular at small distances ($\approx r^{-3}$) and the equation of state of the ultrarelativistic matter is non-ideal ($E \approx T^6$). 7 refs.

41894 (ITF–87-135) **Isotopically symmetric vortices in the sigma-model.** Mishchenko, A.V.; Fomin, P.I. AN Ukrainskoj SSR, Kiev (Ukrainian SSR). Inst. Teoreticheskoj Fiziki. 1987. 15p. (In Russian). Order Number DE90632294. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The existence of quantum-vortex solutions in the linear sigma-model with electroneutral and isotopically non-polrized condensates is shown. 12 refs.

41895 (ITF–88-31) **Finite energy sum rules for the C-odd scattering amplitude.** Jenkovszky, L.L.; Struminskij, B.V.; Shelkovenko, A.N. AN Ukrainskoj SSR, Kiev (Ukrainian SSR). Inst. Teoreticheskoj Fiziki. 1988. 7p. (In Russian). Order Number DE90632295. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

It is shown that the conclusion of K.Igi and P. Kroll on incompatibility of the odderon with the sum rule for the crossing-odd-amplitude is wrong. In order to analyze this problem the well-known finite energy sum rules by Logunov-Soloviev-Tavkhelidze must be used. 9 refs.

41896 (ITF–88-32) **Analytic structure of direct-channel Λ-plane and the form of hadron potential.** Glushko, N.I. AN Ukrainskoj SSR, Kiev (Ukrainian SSR). Inst. Teoreticheskoj Fiziki. 1988. 12p. (In Russian). Order Number DE90632296. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The behaviour of the scattering amplitude in various kinematical regions is investigated by analysing the analytic structure of a complex direct-channel angular momentum plane. Explicit expressions for the differential cross sections in an elastic channel is obtained. It is shown that this method allows one to make some conclusions about the form of hadron potential. 9 refs.

41897 (ITP–88-23) **p-barp elastic scattering in the Coulomb interference region at $\sqrt{s}$=546 GeV.** Jenkovszky, L.L.; Shelkovenko, A.N.; Struminskij, B.V. AN Ukrainskoj SSR, Kiev (Ukrainian SSR). Inst. Teoreticheskoj Fiziki. 1988. 13p. Order Number DE90632297. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The new data on elastic p-barp scattering from the Coulomb interference region at $\sqrt{s}$=546 GeV is shown to be consistent with a model fitted earlier to p-barp and pp data. The ratio $\rho(s)$=ReT(s,o)/ImT(s,o) is found to be ρ (546 GeV)= 0.136. 9 refs., 3 figs., 1 tab.

41898 (IYaF–89-2) **Instantons in QCD: 3. Quark propagators and mesons containing heavy quark.** Shuryak, Eh.V. AN SSSR, Novosibirsk (USSR). Inst. Yadernoj Fiziki. 1989. 23p. Order Number DE90632298. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The instanton-induced effects on the propagators of eight quarks, using the pseudoparticle ensemble obtained previously are studied. It is shown how massless quarks develop some effective mass as they jump from one instanton of another. Correlation functions for mesons made of a light quark and a very heavy antiquark are also calculated, the results are in good agreement with the available experimental data. 12 refs.; 5 figs.

41899 (IYaF–89-15) **Study on the $e^+e^-\to\pi^+\pi^-\pi^0$ process in 2x420-2x510 MeV energy range on VEPP-2M storage ring by means cryogenic magnetic detector.** Barkov, L.M. (and others); Vasserman, I.B.; Vorob'ev, P.V. AN SSSR, Novosibirsk (USSR). Inst. Yadernoj Fiziki. 1989. 14p. (In Russian). Order Number DE90632216. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Cross section of the $e^+e/\to\pi^+\pi^-\pi^0$ process in the energy range from 2x420 to 2x510 MeV is measured at the electron-positron VEPP-2M storage ring using a cryogenic magnetic detector. Dependence of cross section on the energy agrees with forecastings of the vector dominance model taking into account interference ω- and Φ mesons. The optimal value of ω- and Φ-interference phase equals 136±36±10 deg. 15 refs.; 4 figs.; 1 tab.

41900 (JINR–1-34-89, pp. 20-27) **Axial form factors of $K_{\mu 4}$ decay.** Volkov, M.K. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). Joint Inst. for Nuclear Research, Dubna (USSR). 1989. In *JINR rapid communications: Collection.* Order Number DE90706109. Available from NTIS (US Sales Only), PC A05/MF A01; OSTI; INIS.

The box diagrams and the diagrams with an intermediate axial-vector meson K_1 are shown to be important in estimating the axial form factors of the $K_{\mu 4}$ decay. Calculations have been made in the framework of the quark model of a superconducting type, but conclusions are rather general, valid for any linear sigma-model. 10 refs.; 3 figs.

41901 (JINR-D–1,2-88-652/v.1, pp. 9-16) **Possible test of asymptotic behaviours from sum rules.** Keiji, I. (Tokyo Univ. (Japan). Dept. of Physics); Kroll, P. Joint Inst. for Nuclear Research, Dubna (USSR). 1988. (CONF-8806225–: 9. international seminar on high energy physics problems relativistic nuclear physics and quantum chromodynamics, Dubna (USSR), 14-19 Jun 1988). In *Proceedings of the 9. International seminar on high energy physics problems. V. 1.* Order Number DE90706115. Available from NTIS (US Sales Only), PC A20/MF A01; OSTI; INIS.

Theoretical technique using the sum rules to test asymptotic behaviour of pp-bar-scattering total cross section (TCS) and relation of real part of pp-bar-scattering amplitude to its imaginary part ρ pp-bar at 546 GeV energy, measured in different world laboratories is suggested. Sum rules for crossing-odd (spin averaged) forward amplitudes of pp-bar- and pp-scattering are considered. Theoretical evaluations of TCS and ρ pp-bar are presented within the frameworks of reggeon, odderon models and reggeon-odderon model and dispersion relations for the investigated values. Satisfactory result of dispersion relation technique which describes well the Regge asymptotics of ρ pp-bar value is obtained.

41902 (JINR-D–1,2-88-652/v.1, pp. 17-23) **Hamiltonian eigenstates of hadrons in light front QCD including vacuum condensates.** Glazek, St. (Warsaw Univ. (Poland)). Joint Inst. for Nuclear Research, Dubna (USSR). 1988. (CONF-8806225–: 9. international seminar on high energy physics problems relativistic nuclear physics and quantum chromodynamics, Dubna (USSR), 14-19 Jun 1988). In *Proceedings of the 9. International seminar on high energy physics problems. V. 1.* Order Number DE90706115. Available from NTIS (US Sales Only), PC A20/MF A01; OSTI; INIS.

Using variables of QCD light front including vacuum condensates (quark and gluon ones) its shown that interaction of quark-antiquark pair and gluon radiation may be described as Hamiltonian eigenstate of hadron. The conducted calculations show that in variables of the light front of QCD Hamiltonian including gluon condensates it is possible to describe many properties of hadrons in correspondence with the observed values. 12 refs.

41903 (JINR-D–1,2-88-652/v.1, pp. 24-31) **New approach to QCD (gluon sector).** Bogolyubskaya, A.A.; Kalinovskij, Yu.L.; Kallies, W.; Pervushin, V.N. Joint Inst. for Nuclear Research, Dubna (USSR). 1988. (CONF-8806225–: 9. international seminar on high energy physics problems relativistic nuclear physics and quantum chromodynamics, Dubna (USSR), 14-19 Jun 1988). In *Proceedings of the 9. International seminar on high energy physics problems. V. 1.* Order Number DE90706115. Available from NTIS (US Sales Only), PC A20/MF A01; OSTI; INIS.

New approach of minimal quantization to describe in QCD the bound states of gluons (glueballs) both as asymptotic states and a corresponding S matrix is suggested. Oscillation part of gluon interaction potential and effective potential of their interaction as well as wave functions of two-gluon glueballs with zero spin are calculated. 17 refs.; 5 figs.

41904 (JINR-D–1,2-88-652/v.1, pp. 41-50) **Transport theory based on operator-field Langevin equation toward the quark-gluon plasma.** Namiki, M. (Waseda Univ., Tokyo (Japan). Dept. of Physics). Joint Inst. for Nuclear Research, Dubna (USSR). 1988. (CONF-8806225–: 9. international seminar on high energy physics problems relativistic nuclear physics and quantum chromodynamics, Dubna (USSR), 14-19 Jun 1988). In *Proceedings of the 9. International seminar on high energy physics problems. V. 1.* Order Number DE90706115. Available from NTIS (US Sales Only), PC A20/MF A01; OSTI; INIS.

It is suggested to apply transport-field Langevin equation and Nyquist theorem to describe quark-gluon plasma as a semiphenomenological theory between QCD and phenomenology using only quantum properties. Expressions for energy density pressure and entropy of the investigated quark-gluon matter regarding its viscosity as well as temperature dependences of these values are obtained within the framework of hydrodynamic model with regard for transport coefficients. The obtained results are compared with data of other theoretical approaches. 8 refs.; 3 figs.

41905 (JINR-D–1,2-88-652/v.1, pp. 51-55) **Skyrme model and nucleon structure.** Nikolaev, V.A. Joint Inst. for Nuclear Research, Dubna (USSR). 1988. (CONF-8806225–: 9. international seminar on high energy physics problems relativistic nuclear physics and quantum chromodynamics, Dubna (USSR), 14-19 Jun 1988). In *Proceedings of the 9. International seminar on high energy physics problems. V. 1.* Order Number DE90706115. Available from NTIS (US Sales Only), PC A20/MF A01; OSTI; INIS.

Generalized Skyrme model is formulated with regard of the main peculiarities of QCD (production of quark and gluon condensates caused by breaking of chiral and conformal symmetry). As contrast to Skyrme original model it results in the following: chiral symmetry at small distances partially reduces; mass of classical skyrmeon decreases sharply; skyrmeon is very compact object, which results in high value of N-Δ mass splitting; nucleon mass in this model agrees well with experimental value. 4 refs.; 1 fig.

41906 (JINR-D–1,2-88-652/v.1, pp. 56-64) **Quantum effects in the Skyrme model.** Fujii, K. (Hokkaido Univ., Sapporo (Japan). Faculty of Science); Kobushkin, A.P. Joint Inst. for Nuclear Research, Dubna (USSR). 1988. (CONF-8806225–: 9. international seminar on high energy physics problems relativistic nuclear physics and quantum chromodynamics, Dubna (USSR), 14-19 Jun 1988). In *Proceedings of the 9. International seminar on high energy physics problems. V. 1.* Order Number DE90706115. Available from NTIS (US Sales Only), PC A20/MF A01; OSTI; INIS.

Aim of this paper is to investigate quantum structure of SU(2) Skyrme model in particular term of skyrmeon mass within the framework of collective-coordinate formalism. It is shown that new term of negative mass occurs in skyrmean mass which allows to stabilize the rotating chiral solitons. Thus instability problem of such solitons may be reconsidered with regard of new term of negative mass. Problem of skyrmeon stability is considered. 9 refs.

41907 (JINR-D–1,2-88-652/v.1, pp. 65-74) **Chiral bag and hadronic reactions.** Myhrer, F. (South Carolina Univ., Columbia, SC (USA). Dept. of Physics and Astronomy). Joint Inst. for Nuclear Research, Dubna (USSR). 1988. (CONF-8806225–: 9. international seminar on high energy physics problems relativistic nuclear physics and quantum chromodynamics, Dubna (USSR), 14-19 Jun 1988). In *Proceedings of the 9. International seminar on high energy physics problems. V. 1.* Order Number DE90706115. Available from NTIS (US Sales Only), PC A20/MF A01; OSTI; INIS.

Nucleon-nucleon interactions, nucleon-antinucleon annihilation and spin-structure function of nucleon are considered within the framework of the chiral bag model (CBM). Calculations of wave functions for 6q-states, phase shifts of NN-scattering, spin-structure functions of proton and neutron are carried out. CBM is shown to be rough, but reasonable model for the nucleon and it allows to apply it in a wide region of reactions. 37 refs.; 2 figs.

41908 (JINR-D–1,2-88-652/v.1, pp. 75-77) **Exotic mesons-88.** Achasov, N.N. (AN SSSR, Novosibirsk (USSR). Inst. Matematiki). Joint Inst. for Nuclear Research, Dubna (USSR). 1988. (In Russian). (CONF-8806225–: 9. international seminar on high energy physics problems relativistic nuclear physics and quantum chromodynamics, Dubna (USSR), 14-19 Jun 1988). In *Proceedings of the 9. International seminar on high energy physics problems. V. 1.* Order Number DE90706115. Available from NTIS (US Sales Only), PC A20/MF A01; OSTI; INIS.

Problems concerning the existence and search for evident exotic mesons and resonance phenomena (C(1480)-resonance as well as $a_0(980)$ and $f_0(975)$) with hidden exotics using new experiments are discussed. It is suggested to carry out the search for exotic mesons with isospin I_3=0, I_3=2, I_3=±1, I_3=-2 in the following reactions: $\gamma\gamma \to pp$; p-barp $\to \rho^+\rho^-\pi^0$; p-barp $\to (\rho^0\rho^0)\pi^0$; p-barn $\to (\rho^+\rho^-)\pi^-$; p-barn $\to \rho^0\rho^0\pi^-$; $pp \to n(\rho^+\rho^+)n$; $\pi^+p \to \pi^0(\rho^+\rho^+)n$; $k^+p \to k^0(\rho^+\rho^+)n$; $\gamma p \to (\rho^+\rho^0)n$; $\gamma n \to (\rho^-\rho^0)p$. 12 refs.

41909 (JINR-D–1,2-88-652/v.1, pp. 78-86) **Hard hadronic processes with participation of baryons and heavy mesons.** Bajer, V.N. (AN SSSR, Novosibirsk (USSR). Inst. Yadernoj Fiziki); Grozin, A.G. Joint Inst. for Nuclear Research, Dubna (USSR). 1988. (In Russian). (CONF-8806225–: 9. international seminar on high energy physics problems relativistic nuclear physics and quantum chromodynamics, Dubna (USSR), 14-19 Jun 1988). In *Proceedings of the 9. International seminar on high energy physics problems. V. 1.* Order Number DE90706115. Available from NTIS (US Sales Only), PC A20/MF A01; OSTI; INIS.

Semileptonic decays of B mesons: $B \to Dl\nu$-bar, $B \to D^*l\nu$-bar are discussed. Kinematics of $B \to Dl\nu$-bar decay is considered in detail within the system of B-meson rest, formfactors of $B \to D$, $B \to D^*$ processes are introduced, review of the available information for the investigated formfactors is presented. Technique of QCD sum rule is used to calculate the formfactors and results of numerical analysis of sum rule are presented. 8 refs.; 10 figs.

41910 (JINR-D–1,2-88-652/v.1, pp. 96-100) **QCD instanton vacuum and diquark properties.** Musakhanov, M.M. (Tashkentskij Gosudarstvennyj Univ., Tashkent (USSR)); Musatov, I.V. Joint Inst. for Nuclear Research, Dubna (USSR). 1988. (CONF-8806225–: 9. international seminar on high energy physics problems relativistic nuclear physics and quantum chromodynamics, Dubna (USSR), 14-19 Jun 1988). In *Proceedings of the 9. International seminar on high energy physics problems. V. 1.* Order Number DE90706115. Available from NTIS (US Sales Only), PC A20/MF A01; OSTI; INIS.

Behaviour of quarks in instanton vacuum and properties of diquark states are investigated. On the basis of QCD low energy Lagrangians, obtained for the dilute instanton gas, effective Lagrangian, describing quark bound states (diquarks), interacting at the mean instanton radius distances are deduced. It is shown that diquark effective action obtained in terms of QCD instanton vacuum model leads to unsatisfactory in view of phenomenology approach result. 11 refs.

41911 (JINR-D–1,2-88-652/v.1, pp. 101-109) **Nucleon-nucleon potential from models of QCD.** Beyer, M. (Paul Scherrer Inst. (PSI), Villigen (Switzerland)). Joint Inst. for Nuclear Research, Dubna (USSR). 1988. (CONF-8806225–: 9. international seminar on high energy physics problems relativistic nuclear physics and quantum chromodynamics, Dubna (USSR), 14-19 Jun 1988). In *Proceedings of the 9. International seminar on high energy physics problems. V. 1.* Order Number DE90706115. Available from NTIS (US Sales Only), PC A20/MF A01; OSTI; INIS.

Nucleon-nucleon interactions is considered within the framework of the bag compound model in terms of interacting quarks at short and long distances. Mechanism of interacting quarks is considered. Amplitudes and lengths of NN scattering, meson-nucleon coupling constants ϵ, ρ, η, ω, δ, A, D-mesons are calculated using this mechanism. Nucleon-nucleon potentials describing quark-hadron interaction at short distances, static properties of deuteron and electromagnetic scattering on deuteron are discussed. Comparison of different model predictions for Reid soft core, Paris and Bonn ones at two values of the b parameter (quark core radius in 6-quark bag) is carried out. 10 refs., 2 figs., 3 tabs.

41912 (JINR-D–1,2-88-652/v.1, pp. 110-116) **Nucleon in a relativistic constituent quark model.** Weber, H.J. (Virginia Univ., Charlottesville, VA (USA). Inst. of Nuclear and Particle Physics). Joint Inst. for Nuclear Research, Dubna (USSR). 1988. (CONF-8806225–: 9. international seminar on high energy physics

problems relativistic nuclear physics and quantum chromodynamics, Dubna (USSR), 14-19 Jun 1988). In *Proceedings of the 9. International seminar on high energy physics problems. V. 1.* Order Number DE90706115. Available from NTIS (US Sales Only), PC A20/MF A01; OSTI; INIS.

Structure of nucleon and Δ-1232 baryon is considered within the frameworks of relativistic constituent quark model. Calculations of spin wave functions for nucleon and Δ baryon, isospin invariant matrix elements are carried out in terms of light-cone formalism. Axial-vector second-class currents for proton are evaluated. In conclusion it is pointed out that relation between nucleon spin invariants and its second-class axial-vector currents should be taken into account to generate light-front quark dynamics. 12 refs.

41913 (JINR-D–1,2-88-652/v.1, pp. 117-126) **Three- and N-particle systems: dynamical correlation.** Slobodrian, R.J. (Laval Univ., Quebec City, PQ (Canada). Lab. de Physique Nucleaire). Joint Inst. for Nuclear Research, Dubna (USSR). 1988. (CONF-8806225–: 9. international seminar on high energy physics problems relativistic nuclear physics and quantum chromodynamics, Dubna (USSR), 14-19 Jun 1988). In *Proceedings of the 9. International seminar on high energy physics problems. V. 1.* Order Number DE90706115. Available from NTIS (US Sales Only), PC A20/MF A01; OSTI; INIS.

Non-traditional approach to describe many-particle systems (three and n-particle ones) and their interactions is suggested. This approach includes two aims: on the one hand to interpret interaction of many-particle (quark) systems within the framework of Jacobi relative coordinates and kinetic momenta for them. On the other hand discussion of three-quark systems is suggested to conduct in finite unidimensional topology with regard of quark explicit properties, their asymptotic freedom and confinement. Hamiltonian for three-particle nonrelativistic system, harmonic potentials and unified central potentials for many-particle system interactions and its relativistic generalization are obtained. The obtained expressions for three-particle system are used to describe nucleon as constituent three-quark system with regard of quark properties and their interactions. 12 refs.; 1 fig.

41914 (JINR-D–1,2-88-652/v.1, pp. 127-136) **Electromagnetic decay of the Δ isobar in the hybrid nonrelativistic quark model.** Kvitsinskij, A.A. (Leningradskij Gosudarstvennyj Univ., Leningrad (USSR)); Kuperin, Yu.A.; Merkur'ev, S.P.; Yarevskij, E.A. Joint Inst. for Nuclear Research, Dubna (USSR). 1988. (In Russian). (CONF-8806225–: 9. international seminar on high energy physics problems relativistic nuclear physics and quantum chromodynamics, Dubna (USSR), 14-19 Jun 1988). In *Proceedings of the 9. International seminar on high energy physics problems. V. 1.* Order Number DE90706115. Available from NTIS (US Sales Only), PC A20/MF A01; OSTI; INIS.

Hybrid version of nonrelativistic quark model (NRQM) regarding quark relation with pion field is suggested to describe electromagnetic decay of Δ isobar. Electromagnetic formfactors for proton and neutron, helical amplitudes of $\Delta \to N\gamma$ radiative decay, charge radii of proton and neutron, proton electric polarizability, nucleon correlation functions are calculated within the frameworks of NRQM. Electromagnetic characteristics of nucleon and Δ isobar are presented. The constructed hybrid model has allowed to take account self-consistently within the framework of NRQM the pion degrees of freedom and to derive pion contributions to electromagnetic characteristics of N and Δ. 13 refs.; 5 figs.; 1 tab.

41915 (JINR-D–1,2-88-652/v.1, pp. 137-145) **Radiative decays and nuclear structure.** Omelaenko, A.S. (AN Ukrainskoj SSR, Kharkov (Ukrainian SSR). Fiziko-Tekhnicheskij Inst.); Sorokin, P.V. Joint Inst. for Nuclear Research, Dubna (USSR). 1988. (In Russian). (CONF-8806225–: 9. international seminar on high energy physics problems relativistic nuclear physics and quantum chromodynamics, Dubna (USSR), 14-19 Jun 1988). In *Proceedings of the 9. International seminar on high energy physics problems. V. 1.* Order Number DE90706115. Available from NTIS (US Sales Only), PC A20/MF A01; OSTI; INIS.

Review of theoretical calculations for radiative decay amplitudes of nonstrange nucleon resonances is presented. Reactions of radiative capture of π mesons ($\pi N \to N^* \to N\gamma$), meson photoproduction ($\gamma N \to N^* \to (\pi, \rho, \omega)N$) and Compton scattering ($\gamma N \to N^* \to \gamma N$) are the sources of experimental information on radiative decays of nucleon resonances. Decay characteristics of resonances, lost when analyzing the reactions of $\pi N \to \pi N$, $\gamma N \to \pi N$, hybrid resonances: N(1440)P11, N(1535)S11, N(1710)P11, N(1720)P13, electrical quadrupole decay of Δ(1232)P33 isobar are considered. It is pointed out that new experimental data on absolute value of differential cross section of π-mesons photoproduction and their polarization characteristics with high angular and energy resolution on both proton and neutron targets and more precise data on values of radiative decay constants of nucleon resonances with up to 2500 MeV masses are required. 40 refs.; 3 tabs.

41916 (JINR-D–1,2-88-652/v.1, pp. 168-178) **Microscopic description of NN-scattering phases with account of hadron quark structure.** Efimov, G.V.; Ivanov, M.A.; Lyubovitskij, V.E.; Machavariani, A.I.; Chelidze, A.D. Joint Inst. for Nuclear Research, Dubna (USSR). 1988. (In Russian). (CONF-8806225–: 9. international seminar on high energy physics problems relativistic nuclear physics and quantum chromodynamics, Dubna (USSR), 14-19 Jun 1988). In *Proceedings of the 9. International seminar on high energy physics problems. V. 1.* Order Number DE90706115. Available from NTIS (US Sales Only), PC A20/MF A01; OSTI; INIS.

Nucleon as a system including quark and diquark is investigated within the framework of quark confinement model. Main static characteristics of proton and neutron: magnetic moments, electromagnetic radii, G_A/G_V ratio in $n \to pe\nu$ decay - are calculated. Electromagnetic and strong meson-nucleon form factors are obtained as functions of transverse momentum square. NN-scattering phase shifts are calculated in terms of one-boson exchange model. 17 refs.; 4 figs.; 2 tabs.

41917 (JINR-D–1,2-88-652/v.1, pp. 184-189) **Bound states of nonstrange baryons in nonrelativistic quark model.** Inopin, A.E. (AN Ukrainskoj SSR, Kharkov (Ukrainian SSR). Fiziko-Tekhnicheskij Inst.); Inopin, E.V. Joint Inst. for Nuclear Research, Dubna (USSR). 1988. (In Russian). (CONF-8806225–: 9. international seminar on high energy physics problems relativistic nuclear physics and quantum chromodynamics, Dubna (USSR), 14-19 Jun 1988). In *Proceedings of the 9. International seminar on high energy physics problems. V. 1.* Order Number DE90706115. Available from NTIS (US Sales Only), PC A20/MF A01; OSTI; INIS.

Calculation of bound states of nonstrange baryons for (J^P=1/2$^+$, T=1/2) nucleon and (J^P=3/2$^+$, T=3/2) Δ isobar within $\Delta E < 1200$ MeV excitation energy region was conducted in terms of nonrelativistic quark model (NRQM). Calculation was carried out using hyperspherical harmonics technique. The table presents calculation results of mass spectrum for N(J^P=1/2$^+$) and Δ(J^P=3/2$^+$) baryons. Comparison of data calculated in NRQM and experimental ones is carried out. 6 refs.; 1 tab.

41918 (JINR-D–1,2-88-652/v.1, pp. 156-167) **Nucleon-nucleon scattering in 0-3 GeV range as a demonstration of deep attractive potential forbidden states.** Dorodnykh, Yu.L. (Moskovskij Gosudarstvennyj Univ., Moscow (USSR). Nauchno-Issledovatel'skij Inst. Yadernoj Fiziki); Neudachin, V.G.; Obukhovskij, I.T.; Yudin, N.P. Joint Inst. for Nuclear Research, Dubna (USSR). 1988. (In Russian). (CONF-8806225–:). In *Proceedings of the 9. International seminar on high energy physics problems. V. 1.* Order Number DE90706115. Available from NTIS (US Sales Only), PC A20/MF A01; OSTI; INIS.

Model of potentials with forbidden states (PFS), which interprets angular and energy dependence of differential cross sections and polarization in pp scattering at 2.5-3 GeV energy with no adjustment parameters is suggested to describe mass experimental data on nucleon-nucleon scattering. Optical model is used to analyze data on NN-scattering within $E_{lab.}$ >or approx. 1 GeV energy region and nucleons are considered as three-quark clusters. Phase analysis of NN interactions at long and short ranges are carried out. 32 refs.; 3 figs.; 1 tab.

41919 (JINR-D–1,2-88-652/v.1, pp. 271-278) **Transverse momenta of cumulative hadrons and multiquark configurations in nuclei.** Kaidalov, A.B.; Lykasov, G.I.; Slavin, N.V. Joint Inst. for Nuclear Research, Dubna (USSR). 1988. (CONF-8806225–: 9. international seminar on high energy physics problems relativistic nuclear physics and quantum chromodynamics, Dubna (USSR),

14-19 Jun 1988). In *Proceedings of the 9. International seminar on high energy physics problems. V. 1.* Order Number DE90706115. Available from NTIS (US Sales Only), PC A20/MF A01; OSTI; INIS.

Cumulative production of hadrons with large transverse momenta and multiquark configurations in nuclei in pA-reactions in the rest frame of proton target beyond NN interaction kinematic region is considered in terms of quark-gluon string model. Analysis of distributions of q, 2q, 3q, 6q states in nucleus, their distribution functions in nucleus dependning on p_t transverse momentum of quark or quark cluster was carried out. Spectra of pions and protons produced in pA-reactions and calculated as transferred momenta square functions at fixed values of light front variable are shown. Comparison with present experimental data was conducted. It was concluded that mechanism of hadron cumulative production should make allowance for value of transverse momentum of quarks and multiquark clusters in nucleus. 11 refs.; 3 figs.

41920 (JINR-D–1,2-88-652/v.1, pp. 358-365) **On statistical fluctuations in the dibaryon spectra.** Bazhanskij, I.I.; Luk'yanov, V.K.; Reznik, B.L.; Titov, A.I. Joint Inst. for Nuclear Research, Dubna (USSR). 1988. (In Russian). (CONF-8806225–: 9. international seminar on high energy physics problems relativistic nuclear physics and quantum chromodynamics, Dubna (USSR), 14-19 Jun 1988). In *Proceedings of the 9. International seminar on high energy physics problems. V. 1.* Order Number DE90706115. Available from NTIS (US Sales Only), PC A20/MF A01; OSTI; INIS.

The aim of this report is to show, that idea about statistical nature of dibaryon resonances corresponds to the present experimental data. Condition for cross section fluctuation occurrence is linked with value of decay width for isolated dibaryon in nucleon channel. Γ in terms of dibaryon potential quark model and $q^6 \rightarrow$ NN dibaryon decay for q^6 state with S^6 orbital symmetry and (S=I, I=0) deuteron quantum numbers are calculated as an example. np $\rightarrow$ ppπ^-, dp $\rightarrow$ ppn and elastic pp-scattering are considered and distributions of cross sections and correlation functions obtained from these reactions are presented to investigate cross section fluctuations in spectra of effective masses of two-nucleon systems. Supposition about fluctuation pattern does not contradict the experiment. Curves, calculated with $x_i \alpha <$or approx. 0.05 partial amplitude parameter and full width of $\Gamma <$or approx. 20 MeV dibaryon resonances comply to the present experiment best. Fluctuation peculiarities -peaks in cross sections have approximately the same energy width ($\Gamma \approx$ 15-20 MeV) as the observed narrow peak in effective mass spectra of some reactions. 16 refs.; 3 figs.

41921 (JINR-D–1,2-88-652/v.1, pp. 445-454) **Coexistence of multiquark clusters and quark plasma.** Shanenko, A.A.; Yukalov, V.I. Joint Inst. for Nuclear Research, Dubna (USSR). 1988. (In Russian). (CONF-8806225–: 9. international seminar on high energy physics problems relativistic nuclear physics and quantum chromodynamics, Dubna (USSR), 14-19 Jun 1988). In *Proceedings of the 9. International seminar on high energy physics problems. V. 1.* Order Number DE90706115. Available from NTIS (US Sales Only), PC A20/MF A01; OSTI; INIS.

Statistical model of nuclear physics including all types of quark clusters and free quarks is formulated. Nuclear reactions between clusters and quarks are taken into account just as in Dubna group approach. Realistic potentials of multiquark-multiquark interactions are chosen. Quark plasma is considered the way it has been made in Harseev and Moskalenko paper where chemical potential of free quarks is equal to 0 (quarks are produced from vacuum) in their paper while here it is determined by coexistence conditions which does not result in trivial shift of chemical potential. Firmulated model is applicable at all temperatures and within density wide region. 10 refs.; 1 tab.

41922 (JINR-D–1,2-88-652/v.1, pp. 428-436) **Dynamics of phase transitions of quark-gluon plasma into hadrons.** Baranov, S.P. (AN SSSR, Moscow (USSR). Fizicheskij Inst.); Fil'kov, L.V. Joint Inst. for Nuclear Research, Dubna (USSR). 1988. (In Russian). (CONF-8806225–: 9. international seminar on high energy physics problems relativistic nuclear physics and quantum chromodynamics, Dubna (USSR), 14-19 Jun 1988). In *Proceedings of the 9. International seminar on high energy physics problems. V. 1.* Order Number DE90706115. Available from NTIS (US Sales Only), PC A20/MF A01; OSTI; INIS.

Both nonequilibrium (deflagration, detonation and ultrasonic condensation) and equilibrium (evaporation) phase transitions of quark-gluon plasma (QGP) into hadrons are investigated. Production dynamics of supercooled QGP and different consequences of this supercooling are studied. Multiplicities of final hadrons, producted at different patterns of phase transition and their thermodynamic properties are calculated and compared. Dependences of k^+/π^+, k^-/π^- and $(\lambda+\epsilon)/N$ relative yields from baryon density which essentially differ from what is expected at decay of hadron clusters are presented and may be both signal of phase transition and evidence in favour of that or this pattern according to which it is realized. First of all it refers to $(\lambda+\epsilon)/N$ relation. Here one should take account of the fact that λ and ϵ-particles produced from QGP must have zero polarization within certain kinematic regions. 12 refs.; 3 figs.

41923 (JINR-E–2-89-62) **On equal constituent quark masses in different heavy quarkonia potential models.** Lewin, K. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics); Motz, G. Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics. 1989. 11p. Order Number DE90632322. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

In a representative number of more or less QCD-motivated QQ-bar potentials the simultaneous transformations of potentials $V'_i(r)=V_i(r)-V_i(r_0)$, $m'_{Qi}+1/2V_i(r_0)$ (i -model index) introduce approximately equal constituent quark masses $m'_{Qi} \simeq m_Q$ (Q=b,c) for all considered models. The known model independence of $m_{bi}-m_{ci}$ is explained and the influence of the transformation on data reproduction is studied. 16 refs.; 4 figs.; 1 tab.

41924 (JINR-E–2-89-169) **Spin-flip component of the pomeron.** Kopeliovich, B.Z. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems); Zakharov, B.G. Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems. 1989. 6p. Order Number DE90632321. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

Submitted to Phys. Lett., B.

Spin-flip pomeron amplitude is estimated in the Born approximation of QCD using nonrelativistic quark model for the nucleon wave function. Nonzero result is possible if a nucleon contains a dynamically enhanced component with a compact diquark. The proposed model-independent way of the pomeron spin-flip measurement in the nucleon-nuclear interference region is now in progress in the experiment E-704 at the Fermilab TEVATRON. 21 refs.; 2 figs.

41925 (JINR-E–4-89-432) **Proton-proton reaction theory with proton polarizability.** Pupyshev, V.V. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics); Solovtsova, O.P. Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics. 1989. 22p. Order Number DE90632323. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Submitted to Few-Body Syst.

The effect of proton polarizability in pp-scattering and in pp-reaction is considered with including a polarization potential into pp-interaction. Convenient low-energy representations of the pp-scattering function are derived within the variable phase approach and are used for a detailed analytical and numerical analysis of the pp-reaction matrix element considered in the standard impulse approximation. It is proved that for low astrophysical energies this squared matrix element and the contribution from the polarization potential to the astrophysical factor S_{11} may be approximated by linear functions of energy E, while the part of this contribution associated, with the region of distances quasiclassically avoided for the pp-scattering has the $E^{8/3}$ threshold (E$\rightarrow$O) behaviour. 45 refs.

41926 (JINR-R–2-89-375) **The branching processes and the models of hadron multiple production.** Dushutin, N.K. (Irkutskij Gosudarstvennyj Univ., Irkutsk (USSR)); Mal'tsev, V.M. Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics. 1989. 23p. (In Russian). Order Number DE90632324. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The methods of the theory for branching stochastic processes with continuous time are presented. These methods are used for the description of all hadronic multiple production. The conditional probability of branching processes may be obtained by solving

some system of the differential-difference equations. The basis of this system and its properties are discussed. Some analyses of the branching processes are given which are included as elementary processes into the vertex with one additional particle and into the vertex with clusters which undergo decay into several secondary particles. The description of limiting branching processes which contain the clusters with an infinite number of particles and scale invariant behaviour of probability distributions are considered. 17 refs.

41927 (KFKI–1989-60/A) **Order-α radiative corrections for semileptonic decays of unpolarized baryons.** Glueck, F.; Toth, K. Hungarian Academy of Sciences, Budapest (Hungary). Central Research Inst. for Physics. Nov 1989. 41p. Order Number DE90632162. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The theory of the order-α radiative correction to the β-decay of baryons is shortly reviewed. An effective procedure for the calculation of the real photonic part of the order-α correction is outlined. Numerical results are tabulated for the radiative correction to the branching ratio, the electron-antineutrino correlation parameter, the electron energy (E_e) spectrum, the final baryon energy (E_f) spectrum, the electron-antineutrino angular correlation ($\cos\ \theta_{e\nu}$) distribution, as well as to the (E_e, E_f) and the (E_e, $\cos\ \theta_{e\nu}$) two-variable distributions. (author) 26 refs.; 11 tabs.

41928 (KFKI–1989-67/A) **Regular features of predicted multiplicity distributions for very high energies.** Hegyi, S.; Krasznovszky, S. Hungarian Academy of Sciences, Budapest (Hungary). Central Research Inst. for Physics. Dec 1989. 16p. Order Number DE90632327. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The observed energy dependence of the parameters of various multiplicity distributions makes it possible to predict them for even higher energies. Due to its physical importance the behaviour of some quantities that characterize the deviation of predicted multiplicity distributions from the Poisson distribution was investigated. The main result is the observation that the extrapolated ratio of the investigated quantities to maximal rapidity behaves regularly from the 1-2 TeV energy scale reached already by experiments. (author) 13 refs.; 4 figs.

41929 (KFKI–1990-04/A) **A prediction for multiplicity distributions at future hadronic colliders.** Hegyi, S.; Krasznovszky, S. Hungarian Academy of Sciences, Budapest (Hungary). Central Research Inst. for Physics. Jan 1990. 17p. Order Number DE90632328. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Some features of the multiplicity distributions observed in non-diffractive pp and p-antip interactions are investigated. The analysis concentrates mainly on the behaviour of certain momentum combinations that appears to be remarkably smoothly varying in the c.m. energy range 10-900 GeV. Utilizing this empirical regularity, multiplicity distributions at Tevatron, LHC and SSC energies are predicted. (author) 15 refs.; 6 figs.; 3 tabs.

41930 (KFKI–1990-06/A) **Does KNO scaling hold at LEP energies.** Hegyi, S.; Krasznovszky, S. Hungarian Academy of Sciences, Budapest (Hungary). Central Research Inst. for Physics. Feb 1990. 19p. Order Number DE90632329. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Arguments are presented favouring the validity of approximate KNO scaling at LEP energies. The analysis of the multiplicity distributions observed in e^+e^- annihilation by TASSO Collaboration is carried out. Based on an empirical regularity that appears in the behaviour of the momentum combination (n^2) -(n) the expected multiplicity distributions for LEP energies are predicted. Although the investigated data are not massive enough (only 4 distributions), and the interval in average multiplicity is relatively small, it is believed that these predictions will agree with future experimental data from SCL and LEP. (R.P.) 12 refs.; 7 figs.; 4 tabs.

41931 (KFKI–1990-09/A) **Determination of the pion decay constant and quark condensate in the chiral limit.** Gogokhia, V.Sh.; Kluge, Gy.; Magradze, B.A. Hungarian Academy of Sciences, Budapest (Hungary). Central Research Inst. for Physics. Mar 1990. 27p. Order Number DE90632330. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Some basic physical parameters of chiral quantum chromodynamics were calculated within a recently proposed nonperturbative dynamical quark propagator model. The values of the pion decay constant and quark condensant were obtained for reasonable, dynamical quark mass range. Phenomenological estimations of the measured quantities are in good agreement with numerical results. (author) 27 refs.; 5 figs.; 1 tab.

41932 (LPC–89-01) **SU(3) - Symmetry breaking effects in $\gamma\ \gamma \rightarrow$ two mesons processes.** Benayoun, M.; Chernyak, V.L. College de France, 75 - Paris (France). Lab. de Physique Corpusculaire. 1989. 28p. Order Number DE90508321. Available from NTIS (US Sales Only), PC A03/MF A01.

The hard scattering processes $\gamma\ \gamma \rightarrow$ PP, VV and PV (P and V denoting any member of respectively the pseudoscalar and vector octets) are calculated in view of investigating in details the consequences of SU(3)-symmetry breaking effects. Our results greatly differ from those derived earlier. Comparison is done with the available experimental data on $\gamma\gamma \rightarrow \pi^+\pi^-$ and $\gamma\gamma \rightarrow K^+K^-$ cross sections. Some other predictions are also given.

41933 (SLAC-PUB–5085) **Bit-string scattering theory.** Noyes, H.P. Stanford Linear Accelerator Center, Menlo Park, CA (USA). 29 Jan 1990. 26p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00515. (CONF-8909297–2: 11. annual international meeting of the Alternative Natural Philosophy Association, Cambridge (UK), 14-17 Sep 1989). Order Number DE90008013. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

We construct discrete space-time coordinates separated by the Lorentz-invariant intervals h/mc in space and h/mc^2 in time using discrimination (XOR) between pairs of independently generated bit-strings; we prove that if this space is homogeneous and isotropic, it can have only 1, 2 or 3 spacial dimensions once we have related time to a global ordering operator. On this space we construct exact combinatorial expressions for free particle wave functions taking proper account of the interference between indistinguishable alternative paths created by the construction. Because the end-points of the paths are fixed, they specify completed processes; our wave functions are "born collapsed". A convenient way to represent this model is in terms of complex amplitudes whose squares give the probability for a particular set of observable processes to be completed. For distances much greater than h/mc and times much greater than h/mc^2 our wave functions can be approximated by solutions of the free particle Dirac and Klein-Gordon equations. Using a eight-counter paradigm we relate this construction to scattering experiments involving four distinguishable particles, and indicate how this can be used to calculate electromagnetic and weak scattering processes. We derive a non-perturbative formula relating relativistic bound and resonant state energies to mass ratios and coupling constants, equivalent to our earlier derivation of the Bohr relativistic formula for hydrogen. Using the Fermi-Yang model of the pion as a relativistic bound state containing a nucleon-antinucleon pair, we find that $(G_{\pi N}{}^2)^2 = (2m_N/m_\pi)^2 - 1$. 21 refs., 1 fig.

41934 (SSC–154) **Hadron colliders beyond the Z^0.** Quigg, C. Lawrence Berkeley Lab., CA (USA). SSC Central Design Group. Jan 1988. 94p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-89ER40486. (CONF-870821–16: SLAC summer institute on particle physics: looking beyond the Z, Stanford, CA (USA), 10-21 Aug 1987). Order Number DE90013776. Available from NTIS, PC A05/MF A01; OSTI; INIS; GPO Dep.

I summarize the case for new physics at the TeV scale, and review the physics possibilities of multi-TeV hadron colliders. Characteristics of the experimental environment are surveyed. 63 refs., 42 figs., 7 tabs.

41935 (UWThPh–1990-3) **Higher order Bose-Einstein correlations in identical particle production.** Biyajima, M. (Shinshu Univ., Matsumoto, Nagano (Japan). Faculty of Liberal Arts. Dept. of Physics); Bartl, A.; Mizoguchi, T.; Terazawa, O.; Suzuki, N. Vienna Univ. (Austria). Inst. fuer Theoretische Physik. 5 Mar 1990. 15p. (SULDP–1990-1). Order Number DE90632332. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

A diagram technique to calculate the higher order Bose-Einstein correlations is formulated. This technique is applied to derive explicit expressions for the n-pion correlation functions for n = 2, 3, 4, and 5, and numerical predictions are given. In a comparison with the AFS and NA23 data on two-pion and three-pion Bose-Einstein correlations good agreement is obtained. 21 refs., 5 figs. (Authors).

41936 (UWThPh–1990-6) **CP violation in rare K decays.** Ecker, G. Vienna Univ. (Austria). Inst. fuer Theoretische Physik. 12 Feb 1990. 21p. Order Number DE90632333. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The investigation of rare K decays calls for a unified treatment of short- and long-distance aspects as provided by chiral perturbation theory. For the standard model with three generations, the theoretical predictions for signals of CP violation in those decays are reviewed. With direct CP violation as the main target, special emphasis is given to the charge asymmetries in charged K decays and to the especially rare decays $K_L \rightarrow \pi^0$ll-bar. Time dependent rate asymmetries in K^0 decays and the longitudinal muon polarization in $K_L \rightarrow \mu^+\mu^-$ are also discussed. 50 refs., 3 figs., 1 tab. (Author).

41937 (UWThPh–1990-12) **Strings in the abelized picture.** Embacher, F. Vienna Univ. (Austria). Inst. fuer Theoretische Physik. 17 Apr 1990. 18p. Order Number DE90632387. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The transformation properties of the bosonic string variables under the recently discovered abelizing operator are exhibited. The intimate relation of this operator to the light-cone gauge condition is illustrated for the classical string. As an application of the formalism, the derivation of the BRST cohomology by the method of Freeman and Olive is carried over to the abelized picture, where it takes a particulary simple form. 14 refs. (Author).

41938 (UWThPh–1990-18) **Quark and gluon condensates from available data in QCD sum rules.** Parker, J. Vienna Univ. (Austria). Inst. fuer Theoretische Physik. 5 Apr 1990. 21p. Order Number DE90632331. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Within the context of Borel weighted SVZ sum rules, we examine the extent to which condensate values are 'pinned down' by available data. Two sum rules are written down, both of which are, in certain approximation, functions only of a single condensate. We consider changes, by hand, to the d = 8 terms in both light and heavy quark systems, at all times keeping the theoretical framework for the estimation of these terms in mind. We find a degree of support for the approximations of our two sum rules, but cannot use the available data to constrain the d = 8 terms. We conclude that d = 4 gluon condensate and a four quark condensate are quite well determined by available data and reasonable assumptions. 8 figs., 29 refs., 1 tab. (Author).

41939 Pair production of helicity-flipped neutrinos in supernovae. Perez, A. (NASA/Fermilab Astrophysics Center, Fermi National Accelerator Laboratory, Box 500, Batavia, Illinois 60510-0500 (USA)); Gandhi, R. *Physical Review, D (Particles Fields) (USA),* 41(8): 2374-2378 (15 Apr 1990).

We calculate the emissivity for the pair production of helicity-flipped neutrinos, in a way that can be used in supernova calculations. We also present some simple estimates which show that such a process can act as an efficient energy-loss mechanism in the shocked supernova core, and we use this fact to estimate neutrino mass limits from SN 1987A neutrino observations.

41940 Multihadron-event properties in e^+e^- annihilation at $\sqrt{s}$ =52–57 GeV. Li, Y.K.; Li, J.; Cheng, C.P.; Gu, P.; Ye, M.H.; Zhu, Y.C.; Imlay, R.; Kirk, P.; Lim, J.; McNeil, R.R. The AMY Collaboration. *Physical Review, D (Particles Fields) (USA),* 41(9): 2675-2688 (1 May 1990).

We present the general properties of multihadron final states produced by e^+e^- annihilation at center-of-mass energies from 52 to 57 GeV in the AMY detector at the KEK collider TRISTAN. Global shape, inclusive charged-particle, and particle-flow distributions are presented. Our measurements are compared with QCD+fragmentation models that use either leading-logarithmic parton-shower evolution or QCD matrix elements at the parton level, and either string or cluster fragmentation for hadronization.

41941 Electric-charge quantization in the standard model. Rudaz, S. (School of Physics and Astronomy, University of Minnesota, Minneapolis, Minnesota 55455 (USA)). *Physical Review, D (Particles Fields) (USA),* 41(8): 2619-2621 (15 Apr 1990). DOE Contract AC02-83ER40105.

The logic of the construction of the standard model (with the usual minimal set of chiral fermions) as a consistent renormalizable theory necessarily leads to the quantization of electric charge and the absence of massless charged fermions, as well as the automatic cancellation of an anomaly in the divergence of the weak hypercharge current that could arise should a coupling to gravity be contemplated.

41942 Production of top quarks via vector-boson fusion in e^+e^- collisions. Kauffman, R.P. (High Energy Physics Division, Argonne National Laboratory, Argonne, IL (USA)). *Physical Review, D (Particles Fields) (USA),* 41(11): 3343-3347 (1 Jun 1990). DOE Contract W-31109-ENG-38.

The production of top quarks at an e^+e^- collider with a center-of-mass energy of 2 TeV is discussed. Production cross sections for vector-boson fusion processes are calculated using the effective-boson approximation. Included are $\gamma\gamma$, WW, γZ, and ZZ fusion production of top-quark pairs and production of $t\bar{b}$ pairs by γW and ZW fusion. The cross sections for top-quark production from the interactions of beamstrahlung photons are presented.

41943 Bloch-Nordsieck regularization of QCD transverse-momentum distributions. Grau, A. (Universitat Autonoma de Barcelona, Grup de Fisica Teorica, 08193 Bellaterra (Spain)); Pancheri, G.; Srivastava, Y.N. *Physical Review, D (Particles Fields) (USA),* 41(11): 3360-3366 (1 Jun 1990).

An expression for transverse-momentum distributions is presented for Drell-Yan-type processes: it is infrared finite, includes soft-gluon summation in the leading-logarithmic approximation and reproduces the first-order perturbative results at large p_T. In addition, our expression incorporates soft QCD radiative corrections to that part of the cross section where hard bremsstrahlung dominates. We compute W transverse-momentum distributions and average values for a set of different energies: $\sqrt{s}$ =630 GeV, 1.8 TeV, 6 TeV, and 18 TeV.

41944 Analysis of scaled-factorial-moment data. Seibert, D. (School of Physics and Astronomy, University of Minnesota, Minneapolis, Minnesota 55455 (USA)). *Physical Review, D (Particles Fields) (USA),* 41(11): 3381-3387 (1 Jun 1990). DOE Contract FG02-87ER40328.

We discuss the two standard constructions used in the search for intermittency, the exclusive and inclusive scaled factorial moments. We propose the use of a new scaled factorial moment that reduces to the exclusive moment in the appropriate limit and is free of undesirable multiplicity correlations that are contained in the inclusive moment. We show that there are some similarities among most of the models that have been proposed to explain factorial-moment data, and that these similarities can be used to increase the efficiency of testing these models. We begin by calculating factorial moments from a simple independent-cluster model that assumes only approximate boost invariance of the cluster rapidity distribution and an approximate relation among the moments of the cluster multiplicity distribution. We find two scaling laws that are essentially model independent. The first scaling law relates the moments to each other with a simple formula, indicating that the different factorial moments are not independent. The second scaling law relates samples with different rapidity densities. We find evidence for much larger clusters in heavy-ion data than in light-ion data, indicating possible *spatial* intermittency in the heavy-ion events.

41945 Diquarks in the Nambu–Jona-Lasinio model. Thorsson, V. (Department of Physics, State University of New York at Stony Brook, Stony Brook, New York 11794 (USA)); Zahed, I. *Physical Review, D (Particles Fields) (USA),* 41(11): 3442-3445 (1 Jun 1990). DOE Contract FG02-88ER40388.

We investigate the possibility of binding locally two quarks in the Nambu–Jona-Lasinio model. For a range of model parameters consistent with vacuum parameters the scalar, isoscalar, and color-antitriplet diquark is found to bind with a mass of about the

constituent-quark mass. The relevance of this light diquark for baryons in the Nambu–Jona-Lasinio model is discussed.

41946 Composite Higgs bosons in the Nambu–Jona-Lasinio model. Suzuki, M. (Department of Physics, University of California, Berkeley, CA (USA)). *Physical Review, D (Particles Fields) (USA)*, 41(11): 3457-3463 (1 Jun 1990). DOE Contract AC03-76SF00098.

If more than one doublet of composite Higgs bosons is formed with quarks and antiquarks alone in the Nambu–Jona-Lasinio model, their couplings to quarks are subject to interesting constraints. The Higgs doublets orthogonal to the linear combination responsible for mass generation almost decouple with the right-handed *t* quark, but couple with one or more of the right-handed *u*, *d*, *s*, *c*, and *b* quarks with Yukawa coupling constants of order 1. If there are only two light doublets, the doublet orthogonal to the mass-generating combination is likely to couple with the right-handed *b* quark with a Yukawa coupling constant $\cong m_t/v$.

41947 Constraints on supersymmetric particles from the CERN LEP data on Z^0 decay properties. Baer, H. (Physics Department, Florida State University, Tallahassee, FL (USA)); Drees, M.; Tata, X. *Physical Review, D (Particles Fields) (USA)*, 41(11): 3414-3420 (1 Jun 1990). DOE Contract FG05-85ER40215.

We show that the recent measurements of the total Z^0 width and the peak hadronic cross section at CERN LEP lead to, with very mild assumptions, the bounds $m_{\tilde{\nu}} > 36$ GeV, $m_{\tilde{l}_L} > 38$ GeV, and $m_{\tilde{d}_L} > 33$ GeV. For the minimal supersymmetric model, we are able to derive the additional bounds $M_{\tilde{W}^-} > 37$ GeV, $M_{\tilde{Z}_3} > 57$ GeV on the mass of the lighter chargino and third lightest neutralino, respectively, while the bound on $m_{\tilde{d}_L}$ is strengthened to 39 GeV. Finally, some improved strategies for searches of new physics using the peak cross section are commented on.

41948 New constraints on the charged Higgs sector in two-Higgs-doublet models. Barger, V. (Physics Department, University of Wisconsin, Madison, Wisconsin 53706 (USA)); Hewett, J.L.; Phillips, R.J.N. *Physical Review, D (Particles Fields) (USA)*, 41(11): 3421-3441 (1 Jun 1990). DOE Contract AC02-76ER00881.

Two-Higgs-doublet models predict nonstandard physical effects through the interactions of charged Higgs scalars. We analyze the experimental measurements that bound these effects and quantify the resulting constraints on the charged-Higgs-boson mass and coupling parameter $\tan\beta$. We consider low-energy data relating to B_d^0-$\bar{B}_d^0$, D^0-$\bar{D}^0$, and K^0-$\bar{K}^0$ mixing, and high-energy measurements at $p\bar{p}$ colliders relating to searches for the top quark and events with large missing E_T. Our analysis systematically takes account of theoretical uncertainties in bag factors, decay constants, and quark mixing matrix elements by Monte Carlo sampling. We combine our results to determine the regions in the charged-Higgs-boson parameter space that are consistent with present data. An important result is that the Collider Detector at Fermilab top-quark mass bound $m_t > 77$ GeV can probably not be evaded by appealing to $t \to bH^+$ decays, since only a very small sliver of parameter space is consistent with $m_t < 77$ GeV in this scenario. Consistency with either the CERN NA31 or Fermilab E731 ϵ'/ϵ measurements is possible. The rare decays $B \to K^*\gamma$, $K^+ \to \pi^+\nu\bar{\nu}$, and $K_L \to \mu\mu$ are also examined in these models within the context of our combined analysis.

41949 Comment on "Exact eigenvalue equation for a finite and infinite collection of muffin-tin potentials". Gonis, A. (Chemistry and Materials Science Department (L-268), Lawrence Livermore National Laboratory, P.O. Box 808, Livermore, California 94550 (USA)); Zeller, R.; Dederichs, P.H.; Faulkner, J.S. *Physical Review, B: Condensed Matter (USA)*, 41(14): 10224-10225 (15 May 1990).

In a recent paper, Badralexe and Freeman purport to provide a "proof" to the effect that the multiple-scattering-theory treatment of waves propagating through a set of potential cells bounded by nonoverlapping spheres, muffin-tin potentials, is valid only in the limit in which the radius of the sphere vanishes (δ-function potentials). In particular, the authors claim that the well-known Korringa-Kohn-Rostoker method for determining the electronic structure of solids leads to a secular equation which is only approximately valid and cannot give the exact energy levels. It is the purpose of this paper to disprove this claim.

6453 Particle Invariance Principles and Symmetries

Refer also to citation(s) 41932, 41941, 41946, 41947, 41969, 41970, 42102

41950 (IPNO-TH–8920) **The gauged BRST symmetry.** Wallet, J.C. (Paris-11 Univ., 91 - Orsay (FR). Inst. de Physique Nucleaire); Ader, J.P.; Abud, M. Paris-11 Univ., 91 - Orsay (France). Inst. de Physique Nucleaire. Mar 1989. 96p. Order Number DE90508413. Available from NTIS (US Sales Only), PC A05/MF A01.

We develop a systematic method to construct the gauged BRST symmetry for any theory. In this framework, it results as the combination of two basic symmetries of the gauge-fixed theory one considers: the BRST symmetry and the ghost number symmetry, this later being promoted to a local one. From this, we can derive a general relation between the BRST and the ghost number Noether currents. We then take advantage of the present method to elaborate a geometrical algorithm leading to the obtention of the gauged BRST symmetry for a large class of theories, in arbitrary dimensions of space. These involve systems of antisymmetric tensor gauge fields of arbitrary rank, eventually coupled to gravity. This algorithm allows us to derive algebraically the expressions for the possible consistent anomalies of the BRST Noether current algebras; various examples are explicitely discussed. The gauged BRST symmetry for the free bosonic string is also constructed and used to exhibit the link between the trace anomaly and the nilpotency anomaly of the BRST charge operator. In particular, when the Beltrami parametrization is introduced, we show that the corresponding BRST symmetry can be gauged in a way compatible with the holomorphic factorization. A further use of Ward-Slavnov identities constraining the BRST and ghost number current algebra allows us to recover the well-known local counterterm necessary, at the one-loop level, to render the BRST current a good conformal operator.

41951 (NIFS–5) **Symmetry and island structure of the standard map.** Nomura, Y.; Kim, S.Y.; Kamimura, T.; Ichikawa, Y.H. National Inst. for Fusion Science, Nagoya (Japan). Feb 1990. 44p. Order Number DE90508076. Available from NTIS (US Sales Only), PC A03/MF A01.

Even though our primary interest is concerned with stochastic properties of the low dimensional nonlinear dynamical systems, identification of the fixed points and analysis of the periodic orbits are necessary and unavoidable step in the studies of chaotic behaviour. For the case of 2-D area preserving mapping, the symmetry properties of the map provides critical information on the island structure of the mappings. In order to illustrate usefulness of knowledge of the symmetry properties, the periodic orbits of the standard map are discussed in detail by constructing the families of symmetry curves. (author).

6454 Field Theory

Refer also to citation(s) 41769, 41783, 41882, 41940, 41942, 41943

41952 (DOE/ER/13065–630) **Introduction to gauge theories and unification.** Das, A. Rochester Univ., NY (USA). Dept. of Physics and Astronomy. [1990]. 57p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76ER13065. (UR–1172;CONF-900658–1: NATO advanced study institute on techniques and concepts of high energy physics, St. Croix (Virgin Islands (U.S.)), 14-25 Jun 1990). Order Number DE90014473. Available from NTIS, PC A04/MF A01; OSTI; INIS; GPO Dep.

This paper contains the following lectures on gauge theories: basic notations; dimensional regularization; complex scalar field theory; scalar field theory; self-interacting scalar field theory; Noether's theorem; spontaneous symmetry breaking; dirac field theories; local symmetry; quantum electrodynamics; Higgs mechanism; non-Abelian symmetries; and Weinberg-Salam-Glashow theory. (LSP)

41953 (DOE/ER/40171–6) **[Topics in field theory and string theory].** Harvard Univ., Cambridge, MA (USA). Dept. of Physics.

[1990]. 5p. Sponsored by U.S. DOE Energy Research. DOE Contract FG02-84ER40171. Order Number DE90013950. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

In the past year, I have continued to investigate the relations between conformal field theories and lattice statistical mechanical models, and in particular have been studying two dimensional models coupled to quantum gravity. I have continued as well to consider possible extension of these results to higher dimensions and potential applications in other contexts.

41954 (IC–89/232) **Quantization of two dimensional (4,0) supersymmetric theories.** Lhallabi, T. International Centre for Theoretical Physics, Trieste (Italy). Sep 1989. 16p. Order Number DE90631639. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The two-dimensional (4,0) supersymmetric gauge theory and the interaction terms between gauge and matter multiplets are constructed in the harmonic superspace. Functional techniques for the quantization of such theories are discussed. (author). 13 refs.

41955 (IC–90/51) **Higher spin symmetry in lower dimensions.** Fradkin, E.S. (International Centre for Theoretical Physics, Trieste (Italy)); Linetsky, V.Ya. International Centre for Theoretical Physics, Trieste (Italy). Feb 1990. 29p. (CONF-8907203–1: Trieste conference on supermembranes and physics in 2 + 1 dimensions, Trieste (Italy), Jul 1989). Order Number DE90014257. Available from NTIS (US Sales Only), PC A03/MF A01 - OSTI.

In this paper we give a review of our works devoted to the higher spin superalgebras and their localizations in lower dimensions.

41956 (IC–90/57) **A model of interacting strings and the Hagedorn phase transition.** Lizzi, F.; Senda, I. International Centre for Theoretical Physics, Trieste (Italy). Mar 1990. 11p. Order Number DE90631641. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

In this letter we introduce a model of interacting string in which the usual ideal gas approximations are not made. The model is constructed in analogy with nucleation models, the formation of droplets in a supersaturate gas. We consider the strings to be interacting and their number not fixed. The equilibrium configuration is the one for which the time derivatives of the number of strings in the various energies vanishes. We evaluate numerically the equilibrium configurations for various values of the energy density. We find that a density of order one in planck units there is a sharp transition, from a 'gas' phase in which there are many strings, all in the massless or first few excited states, to a 'liquid' phase in which all strings have coalesced into one (or few) highly excited string. (author). 14 refs, 4 figs.

41957 (ITEP–94-89) **New anomaly: nonvanishing interaction of longitudinal real photons in massless quantum electrodynamics.** Gorskij, A.S.; Ioffe, B.L.; Khodzhamiryan, A.Yu. Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow (USSR). Inst. Teoreticheskoj i Ehksperimental'noj Fiziki. 1989. 10p. Order Number DE90631650. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

It is shown that in massless electrodynamics (when the electron mass is strictly zero) the cross section of longitudinal photon interaction on mass shell is nonvanishing. The reasons of appearance of this effects and its possible consequences as well as analogous effects in other quantum field theories (especially non-Abelian gauge theories) are discussed. 7 refs.; 2 figs.

41958 (ITP–87-138) **Scale anomaly and composite scalar bosons with large dynamical dimension in gauge theories.** Miranskij, V.A. (AN Ukrainskoj SSR, Kiev (Ukrainian SSR). Inst. Teoreticheskoj Fiziki); Scadron, M.D. AN Ukrainskoj SSR, Kiev (Ukrainian SSR). Inst. Teoreticheskoj Fiziki. 1987. 12p. Order Number DE90631651. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

In vector-like gauge theories a two-component conception for the gluon condensate is suggested. It is shown that the component connected with spontaneous chiral symmetry breaking can generate a bound state fermion-antifermion scalar mass of magnitude $M_\sigma \simeq 2M_F$. The associated dynamical dimension of the scalar field is $d_\sigma=2$. The application of this approach to QCD is than discussed. 23 refs.

41959 (JINR-D–1,2-88-652/v.1, pp. 437-444) **Deconfinement phase transition and finite-size scaling in SU(2) lattice gauge theory.** Mogilevskij, O.A. (AN Ukrainskoj SSR, Kiev (Ukrainian SSR). Inst. Teoreticheskoj Fiziki). Joint Inst. for Nuclear Research, Dubna (USSR). 1988. (In Russian). (CONF-8806225–: 9. international seminar on high energy physics problems relativistic nuclear physics and quantum chromodynamics, Dubna (USSR), 14-19 Jun 1988). In *Proceedings of the 9. International seminar on high energy physics problems. V. 1.* Order Number DE90706115. Available from NTIS (US Sales Only), PC A20/MF A01; OSTI; INIS.

Calculation technique for deconfinement phase transition parameters based on application of finite-size scaling theory is suggested. The essence of the technique lies in plotting of universal scaling function on the basis of numerical data obtained at different-size final lattices and discrimination of phase transition parameters for infinite lattice system. Finite-size scaling technique was developed as applied to spin system theory. β critical index for Polyakov loop and SU(2) deconfinement temperature of lattice gauge theory are calculated on the basis of finite-size scaling technique. The obtained value agrees with critical index of magnetization in Ising three-dimensional model.

41960 (JINR-E–2-89-13) **On a phase structure of a two-dimensional (Φ-vector^2)^2 field theory.** Efimov, G.V. Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics. 1989. 15p. Order Number DE90631655. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Submitted to Int. J. Mod. Phys. A.

Two models of scalar fields with the interaction Lagrangians $g\Phi^4$ and $g(\Sigma\,\Phi_i^2)^2$ are considered in R^2. There are phase transitions in these models for a certain $g=g_c$. It is shown that the spontaneous symmetry breaking takes place for $g>g_c$. The descripion of two phases for $g<g_c$ and $g>g_c$ is given. The effective coupling constants in perturbation series are less than unity for both the phases so that these models describe the systems with weak coupling. In the second model the Goldstone particles have nonzero masses in the phase $g>g_c$. 7 refs.; 5 figs.

41961 (JINR-E–2-89-58) **Can QCD be a perturbation theory of hadrons.** Pervushin, V.N. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics); Kallies, W.; Kalinovskij, Yu.L.; Sarikov, N.A. Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics. 1989. 35p. Order Number DE90631659. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Submitted to the Talk on 4 Adriatic Meeting on Particle Physics (Dubrovnik, USSR, April 12-22, 1989).

It is found that the S-matrix for atoms and hadrons depends on a gauge as the elementary particles are off mass-shell in the bound states. The S-matrix for bound states should be constructed by the projection of the Belinfante energy-momentum tensor on the Gauss equation solution for the time component with the time-axis chosen as the eigenvector of the bound state total momentum operator. It is shown that this QCD Hamiltonian determined in infrared region by the rising potential anzatz, besides the parton model in the specific gauge, contains also the nonrelativistic potential model for heavy quarkonia, the chiral Lagrangians for light quarkonia with their spectrum, the glueball physics, and the small effective coupling constant in the whole region of transversal momenta. 34 refs.; 6 figs.

41962 (JINR-E–2-89-120) **Green functions of scalar particles in stochastic fields.** Dinejkhan, M.; Efimov, G.V.; Namsrai, K. Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics. 1989. 22p. Order Number DE90631654. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Submitted to Int. J. Theor. Phys.

A variational method of evaluating functional integrals is proposed. This method is applied to investigate the asymptotic behaviour of the scalar particle Green functions in stochastic fields. The equations for the Green functions in the Euclidean space in stochastic fields are written. The solutions of these equations are represented in the form of a functional integral and then they are

averaged over Gaussian stochastic fields. The variational method formulated above is used to evaluate the asymptotical behaviour of these Green functions. 6 refs.

41963 (JINR-E-2-89-359) **On the dynamical generating functional in the stochastic quantization method.** Porchescu, I. (AN Moldavskoj SSR, Kishinev (USSR). Inst. Prikladnoj Fiziki); Namsrai, Kh. Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics. 1989. 10p. Order Number DE90631656. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

A functional integral approach to stochastic quantization method is considered. A probabilistic variant to build a generating functional of stochastic quantization method is proposed. The leading part of the Markov property is emphasized. 17 refs.

41964 (JINR-E-2-89-392) **On renormalization of axial anomaly.** Efremov, A.V. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics); Teryaev, O.V. Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics. 1989. 4p. Order Number DE90631657. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

It is shown that multiplicative renormalization of the axial singlet current results in renormalization of the axial anomaly in all orders of perturbation theory. It is a necessary condition for the Adler - Bardeen theorem being valid. 10 refs.; 2 figs.

41965 (JINR-E-2-89-417) **Transverse-longitudinal part of a vector potential in classical electrodynamics.** Dubovik, V.M. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics); Shabanov, S.V. Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics. 1989. 19p. Order Number DE90631658. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Existence of a physical (gauge-invariant) degree of freedom of the vector potential generating no electromagnetic fields is proved in classical electrodynamics within the Dirac generalized Hamiltonian dynamics. The gauge-invariant form of electrodynamics of charged particles is given within which the question of observing the obtained degree of freedom is discussed. It is shown that it caused an electric current in a superconducting ring put on the solenoid. 20 refs.

41966 (JINR-R-2-89-435) **Relativistic quasipotential of the one-gluon exchange with the running coupling constant.** Kikot', V.I. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics); Skachkov, N.B.; Linkevich, A.D. Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics. 1989. 18p. (In Russian). Order Number DE90631660. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The procedure of an equal-time reduction of the 4-dimentional Bethe-Salpeter formalism for a two-fermion system is modified. Some progress is thus achieved in the construction of a consistent effective description of the relativistic composite systems. The kernel of the wave-function equation is calculated which corresponds to the one-gluon exchange between quarks. The effective coupling constant obtained in the one-loop QCD approximation is used. 17 refs.

41967 (UWThPh-1990-10) **An introduction to integrable models and conformal field theory.** Grosse, H. Vienna Univ. (Austria). Inst. fuer Theoretische Physik. 18 Apr 1990. 34p. Order Number DE90631661. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

We review first the steps which lead to solutions of continuous integrable models in two dimensions. Next we discuss in more detail solvable models of statistical physics. The central role of the Yang Baxter equation is emphasized. The connection to Braids and Knots and certain algebras is mentioned. The continuum limit of lattice models may yield a conformal invariant field theory. The Virasoro algebra is realized in a special manner. The central extension is related to the conformal anomaly. Unitary highest weight representations restrict both the coefficient in front of the anomaly and the conformal weights. The latter are directly related to the critical exponents. The operator product expansion as well as the classification of field operators is mentioned finally. 6 figs., 6 refs. (Author).

41968 Constraints on new macroscopic forces from gravitational redshift experiments. Hughes, R.J. (Los Alamos National Laboratory, University of California, Los Alamos, New Mexico 87545 (USA)). *Physical Review, D (Particles Fields) (USA),* 41(8): 2367-2373 (15 Apr 1990).

The anomalous gravitational redshift arising from hypothetical vector and scalar fields with macroscopic, finite ranges and couplings to matter weaker than gravity is derived. The constraints which could be imposed by redshift experiments on such interactions are analyzed.

41969 Higgs instability in lower-dimensional type-I string theory. Clavelli, L. (Department of Physics and Astronomy, University of Alabama, Tuscaloosa, Alabama 35487 (USA)); Cox, P.H.; Harms, B. *Physical Review, D (Particles Fields) (USA),* 41(8): 2549-2557 (15 Apr 1990). DOE Contract FG05-84ER40141.

In the one-loop-finite six-dimensional type-I theory, a massless multiplet of scalar mesons appears at the tree level which leads at the one-loop level to a Higgs instability. The appearance of small dimensionless numbers is illustrated.

41970 QCD flux tubes for SU(3). Baker, M. (University of Washington, Seattle, Washington 98105 (USA)); Ball, J.S.; Zachariasen, F. *Physical Review, D (Particles Fields) (USA),* 41(8): 2612-2618 (15 Apr 1990). DOE Contract AC06-81ER40048 ;AC03-81ER40050.

We review the physical basis of dual QCD and solve the equations describing a QCD SU(3) flux tube. We use the solution to elucidate the physical connection between QCD and dual superconductivity.

41971 Cosmological production of black holes. Hall, L.J. (Department of Physics, University of California, Berkeley, CA (USA)); Hsu, S.D.H. *Physical Review Letters (USA),* 64(24): 2848-2851 (11 Jun 1990). DOE Contract AC03-76SF00098.

It is argued that, at a first-order phase transition, false-vacuum bubbles may occasionally collapse to become black holes. If the critical temperature T_c is less than a TeV, these black holes, which have a mass proportional to M_{Pl}^2/T_c, could survive until today to be the dark matter. Alternatively, evaporation of black holes could give rise to relic particle abundances.

41972 Hierarchical radiative quark and lepton mass matrices. Ma, E. (Department of Physics, University of California, Riverside, California 92521 (USA)). *Physical Review Letters (USA),* 64(24): 2866-2869 (11 Jun 1990). DOE Contract AT03-87ER40327.

Assuming that only the top quark gets a tree-level mass due to electroweak gauge-symmetry breaking, a model is presented where all other known quarks and leptons acquire radiative masses in a hierarchical manner. This is the first such model where the 3×3 charged-current quark mixing matrix is realistically generated without the fine tuning of parameters.

41973 Soliton solutions to the gauged nonlinear Schroedinger equation on the plane. Jackiw, R. (Department of Physics, Columbia University, New York, NY (USA)); Pi, S. *Physical Review Letters (USA),* 64(25): 2969-2972 (18 Jun 1990).

A gauged, nonlinear Schroedinger equation in two spatial dimensions is considered. This equation describes nonrelativistic matter interacting with Chern-Simons gauge fields. We find explicit static, self-dual solutions that satisfy the Liouville equation.

41974 Nonpolynomial closed-string field theory. Kaku, M. (Institute for Advanced Study, Princeton, New Jersey 08540 (USA)). *Physical Review, D (Particles Fields) (USA),* 41(12): 3734-3747 (15 Jun 1990). DOE Contract AC02-76ER02220.

Recently, we announced the construction of a new nonpolynomial closed-string field theory which successfully reproduced all *N*-point tree amplitudes, thus solving a long-standing problem. This action generalized the four-string tetrahedron interaction that we introduced earlier, which was required to derive the Shapiro-Virasoro model. However, we gave no derivation of the nonpolynomial action. In this paper we present the detailed analysis of its derivation. We calculate all nonpolynomial graphs up to eighth order and their coefficients, and even the coefficients of several infinite series of polyhedra. We use gauge invariance to calculate all coefficients. Because of an enormous redundancy created by a web of

overconstrained equations, we have multiple checks that our coefficients are correctly calculated.

41975 Shapiro-Virasoro amplitude and string field theory. Hua, L. (Physics Department, New York University, New York, New York 10003 (USA)); Kaku, M. *Physical Review, D (Particles Fields) (USA),* 41(12): 3748-3767 (15 Jun 1990). DOE Contract AC02-76ER02220.

One of the embarrassments of covariant string field theory has been the glaring failure to derive the Shapiro-Virasoro amplitude. Modular invariance appears explicitly violated: either the fundamental region is overcounted an infinite number of times, or it is undercounted because of a missing region. We try to approach this problem from a fresh point of view. Conventional wisdom holds that, in string field theory, the Veneziano amplitude can only be derived either in light-cone string field theory or Witten's string field theory. We show that this firmly held belief is actually wrong, that the Veneziano amplitude can actually be derived using vertices of *arbitrary* lengths. This is a highly nontrivial calculation. Using third elliptic integrals we show that a series of "miracles" occurs which allow us to cancel scores of unwanted terms in the measure, leaving us with the correct Koba-Nielsen variable and measure. We give three independent proofs of our result. When we generalize our results to closed-string scattering with arbitrary lengths, we find a new surprise, that we can successfully derive the Shapiro-Virasoro amplitude as long as a crucial four-string interaction term is added. We check by explicit computer calculation that we reproduce the correct region of integration for the four-closed-string amplitude. Crucial to the theory is the existence of the missing four-string tetrahedron graph, which precisely fills the missing integration region. We comment on the implications of this for geometric string field theory.

41976 Light-cone-quantized QCD in 1+1 dimensions. Hornbostel, K. (Newman Laboratory of Nuclear Studies, Cornell University, Ithaca, New York 14853 (USA)); Brodsky, S.J.; Pauli, H. *Physical Review, D (Particles Fields) (USA),* 41(12): 3814-3821 (15 Jun 1990). DOE Contract AC03-76SF00515.

The QCD light-cone Hamiltonian in one space and one time dimension is diagonalized in a discrete momentum-space basis. The hadronic spectrum and wave functions for various coupling constants, numbers of color, and baryon number are computed.

65 PHYSICS II

Refer also to citation(s) 41763

6510 Nuclear Physics

Refer also to citation(s) 40451, 41803, 41804, 41827, 41843, 41844, 41848, 42022, 42051, 42243

41977 (JINR-E-7-89-72) **β-delayed neutron emission of the isotopes ^{20}C, ^{40,41,42}P, ^{43,44}S.** Lewitowicz, M. (Grand Accelerateur National d'Ions Lourds (GANIL), 14 - Caen (France)); Penionzhkevich, Yu.Eh.; Artyukh, A.G. Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions. 1989. 9p. Order Number DE90632707. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

Neutron-rich isotopes have been produced by the fragmentation of 55 MeV/nucleon ^{48}Ca projectiles from GANIL into a ^{181}Ta target. The nuclei were separated by means of the doubly achromatic spectrometer LISE and implanted into a semiconductor telescope for identification in Z and A. Their β-delayed neutron radioactivity is observed by means of a 4π β-neutron coincidence detector. The results include first measurements of the half-life $T_{1/2}$ and the neutron emission probability P_n for the isotopes ^{20}C, ^{40,41,42}P and ^{43,44}S. They are compared with theoretical predictions. 15 refs.; 2 figs.; 2 tabs.

41978 (JINR-R-1-89-112) **The cross sections of π^+ and π^- production at an angle 159 deg l.s. in proton-nuclear interactions at the energy of the incident protons from 15 to 65 GeV.** Belyaev, I.M. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow (USSR). Inst. Teoreticheskoj i Ehksperimental'noj Fiziki); Gavrishchuk, O.P.; Zolin, L.S.; Moroz, N.S.; Peresedov, V.F.; Lobanov, V.V. Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy. 1989. 39p. (In Russian). Order Number DE90632708. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The invariant cross sections of π^+- and π^- pion production at an angle of 159 deg l.s. for interactions of protons having energy E_0 from 15 to 65 GeV with Be,C,Al,Ti,Mo and W nuclei are measured. The data are presented in the tables on the differential cross sections of pion production and their ratios in the momentum range from 250 to 1000 MeV/c in 7 energy intervals of E_0. 6 refs.; 1 fig.; 36 tabs.

41979 (LBL–29076) **Workshop on heavy ion physics at the AGS: Outlook.** Gyulassy, M. Lawrence Berkeley Lab., CA (USA). 25 May 1990. 10p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00098. (CONF-900331–12: Workshop on heavy ion physics at the alternating gradient synchrotron, Upton, NY (USA), 3-7 Mar 1990). Order Number DE90013809. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

This report presents the closing talk of the workshop on AGS heavy ion program held at BNL March 5–7, 1990. The emphasis is on new questions posed by the new data presented at this meeting with emphasis on the pion-proton puzzle. 10 refs., 1 fig., 1 tab.

41980 (NEANDC(E)–312-U-Vol.3-EURATOM) **Annual progress report on nuclear data 1989.** Hansen, H.H. (ed.). Commission of the European Communities, Geel (Belgium). Central Bureau for Nuclear Measurements. ©May 1990. 43p. (INDC(EUR)–024/G;EUR–12822). Available from Office for Official Publications of the European Communities, 2, rue Mercier, L-2985 Luxembourg.

In 1989 the efforts for the improvement of the set of standard neutron cross sections and other quantities selected within the INDC/NEANDC Standards File continued. In particular a detailed study of the nuclear mass and charge distribution of the cold and near cold fission of ^{252}Cf yielded understanding of cold mass rearrangements in nuclei. Accuracy of alpha-particle emission probabilities for major transitions in the decay of ^{236}Pu, ^{239}Pu and ^{243}Am was improved to better than 0.5 %. In the field of nuclear data for fission technology work was concentrated on European requests in the NEA High Priority Request List. In the field of nuclear data for fusion technology, measurements continued aiming at an improvement of relevant data for neutron transport calculations in the blanket and for prediction of gas production. The radionuclide metrology subproject follows three lines: determination of decay-scheme data, preparation of special standards and the improvement of measurement techniques including international comparisons.

6512 Nuclear Properties and Reactions, A = 1-5, Experimental

Refer also to citation(s) 41832, 42213, 42215, 42216, 42219, 42220, 42221, 42222, 42223, 42225, 42226, 42228

41981 (ITEP–106-89) **New results on backward pion-deuteron scattering from 0.83 to 1.16 GeV/c.** Abramov, B.M. (and others); Bulychev, S.A.; Dukhovskoj, I.A. Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow (USSR). Inst. Teoreticheskoj i Ehksperimental'noj Fiziki. 1989. 8p. Order Number DE90632725. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

To solved the contradiction between KEK and LBL data the energy dependence of the differential cross section for the backward ($-1 \leq \cos\Theta_{c.m.s.} \leq 0.98$) pion-deuteron elastic scattering has been systematically measured for negative pion momenta from 0.83 to 1.16 GeV/c. The obtained in a good agreement with the LBL data and do not confirm the existence of a minimum in the energy dependence at 0.96 GeV/c which was found in KEK experiment. Status of the theoretical description of πd elastic scattering in this energy region is discussed. 8 refs.; 2 figs.

41982 (JINR-D–1,2-89-652/v.1, pp. 87-95) **Searches for quark effects in few nucleon reactions.** Abdullin, S.K. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR,

Moscow (USSR). Inst. Teoreticheskoj i Ehksperimental'noj Fiziki); Blinov, A.V.; Chuvilo, I.V. Joint Inst. for Nuclear Research, Dubna (USSR). 1988. (CONF-8806225--:). In *Proceedings of the 9. International seminar on high energy physics problems. V. 1.* Order Number DE90706115. Available from NTIS (US Sales Only), PC A20/MF A01; OSTI; INIS.

Investigations of quark effects in few-nucleon reactions were carried out in the ITEP using a detailed analysis of ^{3}He-p, ^{3}H-p reactions and p-^{3}He $\rightarrow n_F$ ppp charge-exchange reaction where n_F is fast neutrons. Investigations were conducted using 80 cm liquid-hydrogen bubble chamber exposed to ^{3}H and ^{3}He beams with 2.5 and 5 GeV/c momenta within 2.05 T magnetic field. Nucleon momentum distributions in ^{3}He and ^{3}H nuclei, nuclear vertex functions and wave functions of these nuclei were investigated. p^{3}He $\rightarrow n_F$ ppp interaction was considered at the quark level in single scattering approximation. Differential cross sections (DCS) of this interaction at T_p=0.318 GeV and 0.978 GeV energies within the system of ^{3}He nucleus rest, angular distributions of DCS, comparative data of the investigated DCS with predictions of sum rules of Glauber-Sitenko model are presented. Mass spectra of 2p- and 3p systems were studied to investigate dibaryon and tribaryon resonances, predicted in the quark bag model, in p^{3}He $\rightarrow n_F$ ppp reaction. Distributions over M_3p invariant mass in the investigated interaction for different scattering angles of incident proton are given. Production mechanisms for all 9q-states in ^{3}He nucleus are discussed. 23 refs.; 6 figs.

41983 (JINR-D-1,2-88-652/v.1, pp. 366-376) **Fragmentation of relativistic deuterons and deuteron wave function at light front.** Azhgirej, L.S. (and others); Ignatenko, M.A.; Ivanov, V.V. Joint Inst. for Nuclear Research, Dubna (USSR). 1988. (CONF-8806225--:). In *Proceedings of the 9. International seminar on high energy physics problems. V. 1.* Order Number DE90706115. Available from NTIS (US Sales Only), PC A20/MF A01; OSTI; INIS.

New data obtained for momentum spectra of protons in A(d,p)x reactions at 9 GeV/c with large transverse momenta are presented and results of theoretical analysis for these data are given as well. Measurements of proton spectrum from A(d,p)x reaction are conducted using synchrophasotron by means of magnetic spectrometer with wire chamber. Momentum spectra of protons emitted at 0.103 and 0.139 rad angles in ^{1}H(d,p)x reaction at 9 GeV/c are presented. The considered experimental data and their analysis allow to make conclusions: momentum spectra of protons emitted at 0.103 rad angle in A(d,p)x reactions at 9 GeV/c have universality in high-energy parts of these spectra such as independence on nucleus-target type. This fact proves that the investigated spectra depend on the deuteron inner structure. Hard scattering model links behaviour of these spectra with deuteron structure function. 15 refs.; 6 figs.

41984 (JINR-E-1-89-222) **Production of Λ-hyperons and K_s^0 mesons in annihilation of antiprotons in ^{4}He nuclei at 600 MeV/c.** Batusov, Yu.A. (and others); Bunyatov, S.A.; Falomkin, I.V. Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems. 1989. 11p. Order Number DE90632728. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Submitted to Yad. Fiz.

Λ-hyperon and K_s^0-meson production cross sections in antiproton annihilation in ^{4}He at 600 MeV/c have been measured. An anomalously high yield of Λ is observed which is comparable to that of K_s^{0+} $R=\sigma\ \Lambda/\sigma(K)_0.94\pm0.19$. It was shown that the difference in the Λ hyperons and K_s^0 rapidity mesons distributions mey be explained by different mechanisms of production of these particles: K_s^0 mesons are produced mainly in p-bar annihilation on single nucleons from the nucleus, and Λ hyperons in the secondary processes of rescattering of the annihilation mesons. 17 refs.; 4 figs.; 2 tabs.

41985 (JINR-E-1-89-246) **Further evidence for narrow dibaryon states in dp interactions.** Glagolev, V.V. (Joint Inst. for Nuclear Research, Dubna (USSR)); Lebedev, R.M.; Pestova, G.D. Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy. 1989. 11p. Order Number DE90632729. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The experiment has been performed by means of a 1 m hydrogen bubble chamber exposed to a deuteron beam at the synchrofasotron. The dp interactions were investigated at an incident momentum of 3.33 GeV/c. The selection criteria of the kinematic region were proposed and substantiated for an optimum observation of dibaryon states. Narrow structures $\Gamma<50$ MeV with a good statistical significance were found in a two-nucleon mass region of 2010-2020 and 2140-2150 MeV/c^2. All charged configurations of the dibaryon state were observed. 21 refs.; 6 figs.; 3 tabs.

6513 Nuclear Properties and Reactions, A = 6-19, Experimental

Refer also to citation(s) 41836, 41983, 42231

41986 (INS-810) **A note on the origin of secondary hypernuclear γ-quanta from $_\Lambda{}^{10}$B.** Majling, L. (Ceskoslovenska Akademie Ved, Rez (Czechoslovakia). Ustav Jaderne Fyziky); Zofka, J.; Fetisov, V.N.; Lebedev, P.N.; Eramzhyan, R.A. Tokyo Univ., Tanashi (Japan). Inst. for Nuclear Study. Feb 1990. 15p. Order Number DE90508025. Available from NTIS (US Sales Only), PC A03/MF A01.

An alternative interpretation of $_\Lambda{}^{10}$B secondary γ-quanta due to $_\Lambda{}^{10}$B $\rightarrow$ $_\Lambda{}^7$Li + ^{3}He channel is proposed. Its impact on effective ΛN interaction properties and on understanding of $(s^{-1}s_\Lambda)$ configurations is discussed and some verifying experiments are put forward. (author).

41987 (JINR-1-34-89, pp. 5-11) **Measurement of scattering asymmetry of cumulative protons and deuterons emitted at an angle of 95 deg l.s. in pC interactions at energies of incident protons from 17 to 62 GeV. Cumulative proton polarization.** Belyaev, I.M. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow (USSR). Inst. Teoreticheskoj i Ehksperimental'noj Fiziki); Frolov, S.V.; Vlasov, N.V.; Gavrishchuk, O.P.; Zolin, L.S.; Peresedov, V.F. Joint Inst. for Nuclear Research, Dubna (USSR). 1989. (In Russian). In *JINR rapid communications: Collection.* Order Number DE90706109. Available from NTIS (US Sales Only), PC A05/MF A01; OSTI; INIS.

The asymmetry of cumulative proton and deuteron scattering is measured at an angle of 95 deg l.s. for reaction p + ^{12} C $\rightarrow$ d+... in double scattering experiment using a carbon analyzer. The experimental results are obtained over a momentum range of (520-1120) MeV/c for protons and (740-1120) MeV/c for deuterons. The value of cumulative proton polarization is calculated on the basis of the known carbon analyzing power. The momentum, angular and energy dependence of the observed spin effects in the cumulative processes is discussed. 8 refs.; 5 figs.

41988 (JINR-1-34-89, pp. 12-19) **Experimental data on multiple production in central ^{12}C+^{12}C, ^{19}F+^{24}Mg, ^{24}Mg collisions at 3.7 GeV/nucleon.** Anikina, M.Kh. (and others); Abdurakhimov, A.U.; Avramenko, S.A. Joint Inst. for Nuclear Research, Dubna (USSR). 1989. (In Russian). In *JINR rapid communications: Collection.* Order Number DE90706109. Available from NTIS (US Sales Only), PC A05/MF A01; OSTI; INIS.

The multiplicity distributions af π^- mesons and the number of interacting nucleons in central ^{12}C+^{12}C, ^{19}F+^{24}Mg and ^{24}Mg+^{24}Mg interactions at energy of $\approx$ 3.7 GeV/nucleon are presented. The experimental data have been obtained using the spectrometer GIBS with a streamer chamber in a magnetic field. 9 refs.; 3 figs.; 3 tabs.

41989 (JINR-D-1,2-88-652/v.1, pp. 300-307) **(e,e'p) reaction on ^{12}C with cumulative proton.** Egiyan, K.Sh. (Erevanskij Fizicheskij Inst., Erevan (USSR)). Joint Inst. for Nuclear Research, Dubna (USSR). 1988. (In Russian). (CONF-8806225--:). In *Proceedings of the 9. International seminar on high energy physics problems. V. 1.* Order Number DE90706115. Available from NTIS (US Sales Only), PC A20/MF A01; OSTI; INIS.

Experiment linked with investigation of e+^{12}C $\rightarrow$ e'+p+x reaction at E_e=2.0 GeV where secondary proton is cumulative one was conducted to study the processes of cumulative particle production on nuclei. Experiment was conducted using Erevan electron synchrotron, at Deuteron-2 facility which consisted of two spectrometers. Measurements were carried out using 0.024 rad carbon target. The main aim of the measurements was to investigate

spectrum of secondary electrons depending on cumulativity of coincidence proton. Proton angle which adopted four values: ν_{pe}=74 deg, 90 deg, 120 deg and 140 deg - was chosen as parameter for cumulativity change. Measured electron spectra at proton four angles are presented and compared with results of other efforts. Analysis of electron spectra at cumulativity different degrees shows that there is essential difference between these spectra in particular within low-region of transferred energies. It is noted that measurement of energy spectra of cumulative protons at different energies is very important in future experiments. 11 refs.; 4 figs.

41990 (JINR-D-1,2-88-652/v.1, pp. 308-316) **Inclusive production of π^0 mesons in pC interactions at 4.5 GeV/c.** Abraamyan, Kh.U. (Joint Inst. for Nuclear Research, Dubna (USSR)); Arkhipov, V.V.; Astvatsaturov, R.G. Joint Inst. for Nuclear Research, Dubna (USSR). 1988. (In Russian). (CONF-8806225--: 9. international seminar on high energy physics problems relativistic nuclear physics and quantum chromodynamics, Dubna (USSR), 14-19 Jun 1988). In *Proceedings of the 9. International seminar on high energy physics problems. V. 1.* Order Number DE90706115. Available from NTIS (US Sales Only), PC A20/MF A01; OSTI; INIS.

First results of investigations to be conducted at FOTON-MASSER facility at irradiation of different targets by relativistic nuclei beams are presented here. The aim of these efforts is to obtain information necessary to determine mechanism of cumulative effect in hadron production in nucleus-nucleus interactions. Invariant inclusive cross section of $p^{12}C \rightarrow \pi^0X$ reaction at 4.5 GeV/c momentum depending on $p_\perp{}^2$ square of transverse momentum and Feynman variable X_F was measured using statistics of 14 thousands of π^0 mesons. Differential cross section by $p_\perp{}^2$ is parametrized by $f(p_\perp{}^2)$ $A_2\exp(-B_2p_\perp{}^2)$ function with parameter which characterizes inclination of $f(p_\perp{}^2)$ function as equal to B_2=(6.3±0.2) $(GeV/c)^{-2}$. $f(X_F)$ invariant inclusive cross section within $0.50 < X_F < 0.95$ range is parametrizated by $f(X_F)=A_1(1-X_F)^{B_1}$ exponential function with parameter, which characterizes inclination of $f(X_F)$ function as equal to B_1=(2.72±0.14). It agrees with predictions of quark models. Coincidence of $f(X_F)$ invariant inclusive cross sections for $pC \rightarrow \pi X$ reaction at 1.75, 2.89 and 4.5 GeV/c momenta, apparently, indicates that scalingby X_F occurs at 1.75 GeV/c proton momenta. 9 refs.; 7 figs.; 2 tabs.

41991 (JINR-E-1-89-341) **Proton and triton momentum distributions from ^{4}He fragmentation at relativistic energies.** Ableev, V.G. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy); Dzhemukhadze, S.V.; Dimitrov, Ch. Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy. 1989. 8p. Order Number DE90632745. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

Submitted to Few-Body Syst.

The O^0 differential cross section of the $^{12}C(^4He,p)$ and $^{12}C(^4He,t)$ reactions have been measured at beam momenta of 4.52 and 2.69 GeV/c per nucleon, respectively. The proton and triton momentum distributions in ^{4}He are extracted from the cross sections using a relativistic impulse approximation. Some theoretical models based on realistic NN-potentials are examined for obtained data. The triton momentum distribution does not confirm the existence of the theoretically predicted minimum in region of ≈ 400 MeV/c. 18 refs.; 4 figs.

41992 (JINR-R-1-89-240) **Inclusive π^0-production in α C interactions at 4.5 Gev/c per nucleon.** Abraamyan, Kh.U. (Erevanskij Gosudarstvennyj Univ., Erevan (USSR)); Arkhipov, V.V.; Astvatsaturov, R.G. Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy. 1989. 12p. (In Russian). Order Number DE90632746. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Submitted to Yad. Fiz.

The inclusive cross section of the $\alpha C \rightarrow \pi^0X$ reaction at P=4.5 GeV/cxnucleon has been measured as a function of X-cumulative number and squared transverse momentum. The experimental data have been fittd by the functions: E(dσ/d squared transverse momentum) ≈ exp(-ap squared transverse momentum). The following values have been obtaind for X_0 and and a: X_0=0.128±0.003; a=6.7±0.1 $GeV^{-2}xc^2$ for 0<squared transverse momentum≤0.32; a=(10.4±0.1) $GeV^{-2}xc^2$ for 0.32 < squared transverse momentum ≤0.82. 8 refs.; 9 figs.; 2 tabs.

41993 (LBL-29014) **Complex fragment production in 50 MeV/A ^{197}Au + ^{12}C, ^{27}Al, and ^{nat}Cu reactions.** Peaslee, G.F.; Moretto, L.G.; Wozniak, G.J. Lawrence Berkeley Lab., CA (USA). Apr 1990. 20p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00098. (CONF-900147-3: 13. symposium on nuclear physics, Oaxtepec (Mexico), 3-6 Jan 1990). Order Number DE90013846. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

Complex fragment (Z>6) production was studied in three reverse- kinematic reactions: 50 MeV/A ^{197}Au + ^{12}C, ^{27}Al, and ^{nat}Cu. Typical inclusive cross sections are shown, as well as exclusive results for 2- , 3-, and higher-fold events. Reconstructing the source velocity of these fragments and using a simple incomplete fusion model gives a reliable measure of the impact parameter and excitation energy of the reactions producing these fragments. A clear progression from peripheral (cold) events to more central (very hot) events is seen,as function of source velocity. The primary production of fragments in the ^{197}Au + ^{12}C and ^{27}Al reactions is consistent with statistical emission from a thermalized source, up to approximately 5 MeV/A of excitation energy. For the ^{nat}Cu target, another significant source of fragment emission is observed. 20 refs., 15 figs.

41994 (LBL-29090) **Binary and multifragment decay of very hot nuclei.** Moretto, L.G.; Blumenfeld, Y.; Charity, R.J.; Wozniak, G.J. Lawrence Berkeley Lab., CA (USA). May 1990. 14p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00098. (CONF-9004220--2: International workshop on nuclear dynamics, Elba (Italy), 2-7 Apr 1990). Order Number DE90014186. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

Compound binary emission of complex fragments is illustrated for a variety of reactions. Complex fragment emission from 35 and 40 MeV/N ^{139}La + ^{12}C, ^{27}Al, ^{40}Ca and ^{51}V reactions has been studied. Multifragment events from these reactions were assigned to sources characterized by their energy and mass through the incomplete-fusion-model kinematics. Excitation functions for the various multifragment channels appear to be nearly independent of the system and bombarding energy. Preliminary comparisons of the data with sequential-statistical-decay calculations are discussed. 14 refs., 7 figs.

6514 Nuclear Properties and Reactions, A = 20-38, Experimental

Refer also to citation(s) 41988, 41993, 41994

6515 Nuclear Properties and Reactions, A = 39-58, Experimental

Refer also to citation(s) 41994, 42231

41995 (RI-211) **Analytical expression of the fast neutron energy spectrum at finite geometry of experiment.** Yakovlev, V.A. Radievyj Inst., Leningrad (USSR). 1988. 12p. (In Russian). Order Number DE90632756. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The exact analytical expression of the spectrum shape of neutrons, arising from the charge particle irradiation of thin round target and passing through round sample is obtained. The calculations of the neutron spectra from T(p,n) reaction for targets with various thickness and radii are carried out. The geometries of target-sample in form diskring, ring-disk and ring-ring are also considered. The considerable sensitiveness ofneutron spectrum-shape to the change of proton beam radius and target thickness is shown. 6 refs.; 5 figs.

6516 Nuclear Properties and Reactions, A = 59-89, Experimental

Refer also to citation(s) 41242, 41993, 41994

41996 (BARC-1471) **Measurement and analysis of the excitation function for alpha induced reaction on Ga and Sb isotopes.** Ismail, M. (Variable Energy Cyclotron Centre, Calcutta

(India)). Bhabha Atomic Research Centre, Bombay (India). 1989. 52p. Order Number DE90632759. Available from NTIS (US Sales Only), PC A04/MF A01; OSTI; INIS.

Excitation functions for the reactions ^{69}Ga(αxn)sup(73-x)As, ^{69}Ga(α,p3n)^{69}Ge, ^{69}Ga(α,2p4n)^{67}Ga, ^{71}Ga(α,xn)sup(75-x)As, ^{121}Sb(α,xn)sup(125-x)I, ^{121}Sb(α,p3n)^{121}Te and ^{123}Sb(α,xn)sup(127-x)I were obtained from the measurements of the residual activity of stacked foils of gallium nitrate evaporated on aluminium backings from threshold to 65 MeV. The excitation functions for the production of ^{74}As, ^{72}As, ^{71}As, ^{69}Ge and ^{67}Ga from α - induced reactions on Ga and ^{126}I, ^{124}I, ^{123}I, ^{121}I and ^{121}Te from α-induced reactions on Sb are presented. The experimental data are compared with calculations considering equilibrium as well as pre-equilibrium reaction mechanism according to the hybrid model of Blann (1971). The high energy part of the excitation functions are dominated by the pre-equilibrium reaction mechanism. Calculations were done using the a priori calculational method of Overlaid Alice Code of Blann. From the reactions ^{71}Ga(α,3n)^{72}As and ^{123}Sb(α,3n)^{124}I an initial exciton number nsub(o)=4(nsub(n)=2, nsub(p)=2, nsub(h)=0) with the mean free path multiplier parameter k set to 2 has been deduced for both the targets. However, there are a few exceptions. The theory overestimates the cross-section for the ^{69}Ga(α,2p4n)^{67}Ga reaction whereas it underestimate the cross-section for the ^{121}Sb(α,p3n)^{121}Te reaction and the high energy tail of ^{121}Sb(α,2n)^{123}I excitation function. Factors to which these discrepancies between theory and experiment in case of these reactions may be attributed are indicated. Barring these reactions the overall agreement between theory and experiment is good taking into account the limitations of the theory. (author). 43 refs., 7 tabs., 19 figs.

41997 (JINR-R–1-89-213) **Central interactions of ^{22}Ne nuclei with heavy photoemulsion nuclei at P_0=4.1 A GeV/c.** Andreeva, N.P. (AN Kazakhskoj SSR, Alma-Ata (USSR). Inst. Fiziki Vysokikh Ehnergij); Anzon, Z.V.; Ameeva, B.U. Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy. 1989. 10p. (In Russian). Order Number DE90632760. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

The data on multiplicity and angular distributions of secondary particles of central interactions of neon-22 nuclei with Ag, Br photoemulsion heavy nuclei are presented. The fluctuations of relativistic particle density have been studied over pseudorapidity and the groups of particles have been found with the density $p\eta \geq 60$ (per rapidity unit) which formed - 20% of the total Ne-Ag, Br central interactions. Among central interactions peculiar events with minimum angle of shower particles $\Theta_{min} > 7$ deg have been found. From the analysis of angular distribution of shower particles and momentum balance the values of transverse momentum p for secondary particles in peculiar events (taking into account neutral particles) and for all special events with $p^* = (0.61 \pm 0.05)$ GeV.c have been obtained. This is considerably higher than $p^* = 0.38$ GeV/c for chargd shower particles over all the interactions. 9 refs.; 8 figs.; 3 tabs.

6517 Nuclear Properties and Reactions, A = 90-149, Experimental

Refer also to citation(s) 41832, 41833, 41996, 41997

41998 (ANL/NDM–116) **Neutron scattering from elemental indium, the optical model, and the bound-state potential.** Nuclear data and measurements series. Chiba, S. (Japan Atomic Energy Research Inst., Tokai, Ibaraki (Japan)); Guenther, P.T.; Lawson, R.D.; Smith, A.B. Argonne National Lab., IL (USA). Jun 1990. 26p. Sponsored by U.S. DOE Energy Research. DOE Contract W-31109-ENG-38. Order Number DE90014222. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

Neutron differential elastic-scattering cross sections of elemental indium are measured from 4.5 to 10 MeV at incident-energy intervals of ≈500 keV. Seventy or more differential values are obtained at each incident energy, distributed between ≈18° and 160°. These experimental results are combined with lower-energy values previously obtained at this laboratory, and with 11 and 14 MeV results in the literature, to form a comprehensive elastic-scattering database extending from ≈1.5 to 14 MeV. These data are interpreted in terms of a conventional spherical optical model. The resulting potential is extrapolated to the bound-state regime. It is shown that in the middle of the 50–82 neutron shell, the potential derived from the scattering results adequately describes the binding energies of article states, but does not do well for hole states. The latter shortcoming is attributed to the holes states having occupational probabilities sufficiently different from unity, so that the exclusion principle become a factor, and to the rearrangement of the neutron core. 68 refs.

41999 (JINR-E–6-89-60) **Decay of oriented ^{149}Nd and low-lying levels in the N=88 ^{149}Pm nucleus.** Simecek, P. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems); Finger, M.; Tsupko-Sitnikov, V.M.; Prochazka, I.; Konicek, J.; Janout, Z. Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems. 1989. 14p. Order Number DE90632771. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Submitted to J. Phys., G.

Levels of the ^{149}Pm nucleus populated in the ^{149}Nd decay were studied by using the low-temperature nuclear orientation technique. The parent ^{149}Nd nuclei were oriented in a gadolinium host. The normalized γ-ray intensities were determined for twenty seven transitions in the daughter ^{149}Pm nucleus. The characteristics of ^{149}Pm at 288.2 and 425.3 keV were determined as $9/2^+$ and $7/2^+$, respectively, and the previous spin-assignments could be unambiguosly confirmed for several other levels in ^{149}Pm. The substantial new information on multipole mixing ratios of γ-rays in ^{149}Pm is presented. The quasiparticle-rotor model was applied to the description of the structure of the low-lying levels in ^{149}Pm. 22 refs.; 2 figs.; 5 tabs.

42000 (JINR-E–15-89-44) **Studies of isomeric ratios in the photonuclear reactions, induced by bremsstrahlung in the energy range from 15 to 20.5 MeV.** Thiep, T.D. (National Inst. for Nuclear Research, Da Lat (Viet Nam)); An, T.T.; Minh, D.A.; Khai, N.T.; Luc, H.D.; Kolev, D. Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions; National Inst. for Nuclear Research, Da Lat (Viet Nam). 1989. 8p. Order Number DE90632770. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

Submitted to J. Inorg. Nucl. Chem.

The experimental results for isomeric cross section ratios in the photonuclear reactions ^{142}Nd(γ,n) ^{141m,g}Nd, ^{144}Sm(γ,n) ^{143m,g}Sm, ^{90}Zr(γ,n)^{89m,g}Zr and ^{110}Pd(γ,n) ^{109m,g}Pd induced by bremsstrahlung with energy maximum from 15 to 20.5 MeV were compared to statistical model calculations using the method of Huizenga and Vandenbosch. It is shown tht in this energy range the statistiical model is applicable for the description of photonuclear reactions and the equilibrium process is predominant, but in the higher energy part, pre-equilibrium and direct processes schould be taken into account. 24 refs.; 2 figs.; 1 tab.

42001 (JINR-R–6-88-911) **Excitation functions and yields for ^{111}In production using ^{113,114,nat}Cd(p,xn)^{111}In reactions with ≈ 65 MeV protons.** Zajtseva, N.G. (and others); Knotek, O.; Kovalev, A. Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems. 1988. 16p. (In Russian). Order Number DE90632772. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Submitted to Int. J. Appl. Radiat. Isot.

Excitation functions for the ^{113}Cd(p,3n)^{111}In and ^{114}Cd(p,4n)^{111}In reactions were measured by the stacked-foil technique in the energy range from 63 to 3 MeV. The results were compared with theoretical calculations based on the hybrid model using the well developed computer code ALICE. For the same energy range, the effective cross-sections were determined for the ^{nat}Cd(p,xn)^{111}In reactions. At the initial proton energy of 63 MeV for production of ^{111}In from ^{113}Cd,^{114}Cd and ^{nat}Cd the cumulative yields were found as 16.7; 15.7 and 10.4 mCi/μAh, respectively. The contamination of the undersired nuclide ^{114m}In was determined. The carrier-free ^{111}In activity was separated from the cadmium cyclotron-target by procedure based on ion exchange chemistry. Th radionuclide purity of the final radioindium was determined. 30 refs.; 6 figs.; 6 tabs.

6518 Nuclear Properties and Reactions, A = 150-189, Experimental

42002 (JINR-1-34-89, pp. 37-41) **Detection and study of the α-decay of the compound states ^{188}Os.** Andrzejewski, J. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Neutron Physics); Gledenov, Yu.M.; Popov, Yu.P.; Sedyshev, P.V. Joint Inst. for Nuclear Research, Dubna (USSR). 1989. In *JINR rapid communications: Collection.* Order Number DE90706109. Available from NTIS (US Sales Only), PC A05/MF A01; OSTI; INIS.

The paper reports on the results of the study of the α-decay of highly excited states of ^{188}Os. The experiment was performed by the time-of-flight method and utilized neutrons from the IBR-30 booster. For the first time one has succeeded in measuring, with the help of a two-section ionization chamber with a grid, α-widths of $(6.8\pm1.0)\times10^{-9}$ eV and $(2.0\pm0.3)\times10^{-9}$ eV for two resonances at E_0=9.47 eV and E_0=12.7 eV, respectively. Average α-widths were found to be $(17\pm10)\times10^{-9}$ eV and $(6.3\pm4.7)\times10^{-9}$ eV over two neutron energy intervals from 38 to 53 eV, and from 53 to 150 eV, respectively. Experimental alpha-particle strength functions are compared to those calculated within the model of the black nucleus. 11 refs.; 2 figs.; 1 tab.

42003 (JINR-E-1-89-252) **Nuclear reactions of tantalum with 3.65 AGeV ^{12}C-ions and 3.65 GeV protons.** Kozma, P. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy); Damdinsurehn, Ts.; Chultehm, D.; Tumehndehmbehrehl, B. Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy. 1989. 22p. Order Number DE90632773. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Submitted to Nucl. Phys., A.

The cross sections of a number of target residues producted in the reactions of 3.65 AGeV ^{12}C-ions and 3.65 GeV protons with tantalum have been measured. The measurements have been done by direct counting of irradiated targets with a Ge(Li) gamma-ray spectrometer. Charge dispersions and mass-yield distributions were deduced from these data. The results are discussed in terms of the basic concepts of high-energy nuclear physics. They are also compared with intranuclear cascade and stripping model calculations. 36 refs.; 8 figs.; 5 tabs.

42004 (JINR-R-15-89-116) **On the search for superdense nuclei.** Avdeev, S.P. Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems. 1989. 8p. (In Russian). Order Number DE90632774. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

Reported at the 2-nd Conference of Young Scientists of the Laboratory of Nuclear Reactions, JINR, DUbna, January 5-7, 1988.

The experiments on the search for superdence nuclei among the products of interaction of relativistic p,d,He,C with tantalum and tungsten are described. Nuclear reactions of the superdense phase in the above products were supposed to manifest themselves by the abnormal coupling energy of the nuclei produced = or by multiple emission of delayed nucleons. No anomalous nuclei were found. The upper limits of cross sections for suprdense nuclei are given for the half-lives from 10^{-7} to 10^{5} s. 14 refs.; 5 figs.; 1 tab.

42005 (LBL-28981) **Nuclear-decay studies of neutron-rich rare-earth nuclides.** Chasteler, R.M. (California Univ., Berkeley, CA (USA). Dept. of Chemistry). Lawrence Berkeley Lab., CA (USA). 26 Apr 1990. 125p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00098. Order Number DE90013358. Available from NTIS, PC A06/MF A01; OSTI; INIS; GPO Dep.

Neutron-rich rare-earth nuclei were produced in multinucleon transfer reactions of ^{170}Er and ^{176}Yb projectiles on ^{nat}W targets at the Lawrence Berkeley Laboratory SuperHILAC and their radioactive decays properties studied at the on-line mass separation facility OASIS. Two unknown isotopes, ^{169}Dy ($t_{1/2}$ = 39 ± 8 s) and ^{174}Er($t_{1/2}$ = 3.3 ± 0.2 m) were discovered and their decay characteristics determined. The decay schemes for two previously identified isotopes, ^{168}Dy ($t_{1/2}$ = 8.8 ± 0.3 m) and ^{171}Ho ($t_{1/2}$ = 55 ± 3 s), were characterized. Evidence for a new isomer of 3.0 m ^{168}Ho^{g}, ^{168}Ho^{m} ($t_{1/2}$ = 132 ± 4 s) which decays by isomeric transition (IT) is presented. Beta particle endpoint energies were determined for the decay of ^{168}Ho^{g}, ^{169}Dy, ^{171}Ho, and ^{174}Er, the resulting Qβ-values are: 2.93 ± 0.03, 3.2 ± 0.3, 3.2 ± 0.6, and 1.8 ± 0.2 MeV, respectively. These values were compared with values calculated using recent atomic mass formulae. Comparisons of various target/ion source geometries used in the OASIS mass separator facility for these multinucleon transfer reactions were performed. 73 refs., 40 figs., 11 tabs.

6519 Nuclear Properties and Reactions, A = 190-219, Experimental

42006 (DOE/ER/40467-5) **[Study of high energy nucleus-nucleus interactions with a Magnetic-Interferometric-Emulsion-Chamber]: Progress report, July 1, 1989-Present.** Takahashi, Yoshiyuki. Alabama Univ., Huntsville, AL (USA). Dept. of Physics. 25 Jun 1990. 5p. Sponsored by U.S. DOE Energy Research. DOE Contract FG05-88ER40467. Order Number DE90013955. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

The Nuclear Physics group at the University of Alabama in Huntsville (UAH) has been analyzing 200 GeV/n S + Pb collision events with a Magnetic-Interactive-Emulsion-Chamber (MAGIC). The objectives of the research are to learn the nature of nuclear matter at high density of particles and to develop an all-particle tracking system for very high particle densities. To advance the study further, the detector capability has been improved so as to allow the best utilization of all-particle measurements. A design study for Pb + Pb interactions at 160 GeV/n was made for planned experiments in 1993.

42007 (JINR-R-6-89-200) **Direction correlations of γ-rays in ^{211}At.** Venos, D. (and others); Bonch-Osmolovskaya, N.A.; Hons, Z. Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems. 1989. 12p. (In Russian). Order Number DE90632780. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

By means of gamma-gamma angular correlations with a multidetector device (seven Ge(Li) detectors) angular distribution coefficients have been measured for 18 cascades of gamma-transitions observed at ^{211}Rn→^{211}At decay. For the first time unambiguous spin values for 10 levels were determined, as well as the values of mixing ratio parameter δ for eight gamma-transitions. 14 refs.; 2 figs.; 2 tabs.

6520 Nuclear Properties and Reactions, A = 220 and Above, Experimental

Refer also to citation(s) 40690, 40692

42008 (JAERI-M-90-030) **Remeasurement of ^{242}Cm half-life.** Usuda, Shigekazu (Japan Atomic Energy Research Inst., Tokai, Ibaraki (Japan). Tokai Research Establishment); Suzuki, Toshio; Kohno, Nobuaki; Umezawa, Hirokazu. Japan Atomic Energy Research Inst., Tokyo (Japan). Feb 1990. 16p. (In Japanese). Order Number DE90508037. Available from NTIS (US Sales Only), PC A03/MF A01.

The half-life of ^{242}Cm has been remeasured by three independent methods. The first method was α-activity counting with a 2π proportional counter which was the same as that previously applied, and the second one was α-ray spectrometry with an Si detector with relatively low geometry. The third method was γ(X)-ray spectrometry with a pure Ge detector for low energy measurement that has not been applied yet by anyone for the ^{242}Cm half-life measurement. The overall weighted mean of the measurements was 161.41 d with a standard deviation of the mean 0.28 d. The ^{242}Cm half-life value remeasured agrees well with our previous measurement result (161.35±0.30 d), but shorter by about 1 % than values reported by the others. (author).

42009 (JAERI-M-90-101) **Evaluation of neutron nuclear data for curium isotopes.** Nakagawa, Tsuneo. Japan Atomic Energy Research Inst., Tokai, Ibaraki (Japan). Tokai Research Establishment. ©Jul 1990. 94p. Sponsored by Japan Atomic Energy Research Institute. (NEANDC(J)-152/U;INDC(JPN)-139/L). Available from Japan Atomic Energy Research Institute, Tokai-mura, Naka-gun, Ibaraki-ken 319-11, Japan.

The evaluation of neutron nuclear data of curium isotopes was made in the energy region from 10^{-5} eV to 20 MeV. The data of ^{241}Cm were newly evaluated in the present work. The data of ^{242}Cm, ^{243}Cm, ^{244}Cm, ^{245}Cm, ^{246}Cm, ^{247}Cm, ^{248}Cm, and ^{249}Cm had been evaluated previously, and those of ^{242}Cm through ^{245}Cm were stored in JENDL-2. In the present work, the recent experimental data were reviewed, and their data were reevaluated except for ^{248}Cm and ^{249}Cm. The results of the present work were compiled in ENDF-5 format and included in the latest version of Japanese Evaluated Nuclear Data Library, JENDL-3.

42010 (JINR–1-34-89, pp. 50-54) **Experiments on the study of ^{263}Ku stability.** Bruchertseifer, H. (Akademie der Wissenschaften der DDR, Leipzig (German Democratic Republic). Zentralinstitut fuer Isotopen- und Strahlenforschung); Buklanov, G.V.; Ivanov, M.P. Joint Inst. for Nuclear Research, Dubna (USSR). 1989. (In Russian). In *JINR rapid communications: Collection.* Order Number DE90706109. Available from NTIS (US Sales Only), PC A05/MF A01; OSTI; INIS.

Experiments of the synthesis of ^{263}Ku isotope in ^{248}Cm (^{22}Ne, α3n) reaction on U-300 and U-400 cyclotrons are described. Radiochemical selection of Ku and 102 element fractions and preparing the spectrometric sources were carried out. The following measurement on a setup containing detectors of fragments, gamma-quanta and neutrons of fission was made for Ku fraction and on track detectors for 102 element fraction. No spontaneous fission event was registered in all irradiations. It was concluded that the alpha-decay branch is not principal for ^{263}Ku. If spontaneous fission is the main branch of decay, then the half-life of ^{263}Ku is less than 20 min. 13 refs.; 1 tab.

6530 Nuclear Theory

Refer also to citation(s) 41840, 41841, 41842, 41845, 41846, 41847, 41849, 41851, 41852, 41853, 41888, 41919, 42006, 42296

42011 (CONF-900289–6) **Narrow structures observed in the p-p analyzing power.** Hajime, Shimizu (Yamagata Univ. (Japan). Dept. of Physics). RING (E174) Collaboration. Texas A and M Univ., College Station, TX (USA). [1990]. 8p. Sponsored by U.S. DOE Energy Research. DOE Contract FG05-88ER40399. From International workshop on the polarized ion sources and polarized gas jets; Tsukuba-Shi (Japan); 12-17 Feb 1990. Order Number DE90014348. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

The momentum dependence of the p-p elastic analyzing power has been measured in small steps using an internal target during polarized beam acceleration from 1 to 3 GeV/c. The momentum bin size ranges from 5 to 18 MeV/c. The relative uncertainty of the analyzing power is typically less than 0.01 for each momentum bin. Narrow structures have been observed in the two-proton invariant mass distribution of the analyzing power. A brief discussion on the interpretation of the present results is also given. 11 refs., 7 figs., 1 tab.

42012 (CONF-900388–4) **A neural-network approach to the problem of photon-pair combinatorics.** Awes, T.C. Oak Ridge National Lab., TN (USA). Jun 1990. 8p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. From International workshop on software engineering, artificial intelligence and expert systems for high energy and nuclear physics; Lyon (France); 19-24 Mar 1990. Order Number DE90014212. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

A recursive neural-network algorithm is applied to the problem of correctly pairing photons from π^0, η, and higher resonance decays in the presence of a large background of photons resulting from many simultaneous decays. The method uses the full information of the multi-photon final state to suppress the selection of false photon pairs which arise from the many combinatorial possibilities. The method is demonstrated for simulated photon events under semirealistic experimental conditions. 3 refs., 3 figs.

42013 (CONF-8909299–2) **Observation of narrow structures in the p-p analyzing power around 1 GeV.** Hajime, Shimizu (Yamagata Univ. (Japan). Dept. of Physics). RING (E174) Collaboration. Texas A and M Univ., College Station, TX (USA). [1989]. 8p. Sponsored by U.S. DOE Energy Research. DOE Contract FG05-88ER40399. From 5. French-Japanese symposium on nuclear physics; Dogashima (Japan); 26-30 Sep 1989. Order Number DE90014349. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

The momentum dependence of the analyzing power Ay in proton-proton elastic scattering has been measured in small steps using an internal target inserted into a polarized proton beam during acceleration from 1 to 3 GeV/c. The momentum bin size ranges from 5 to 18 MeV/c. The relative uncertainty of the analyzing power, ΔAy, is typically less than 0.01 for each momentum bin. Narrow structures have been observed in the two-proton invariant mass distribution of the analyzing power. 15 refs., 5 figs., 1 tab.

42014 (CONF-9005221–6) **Nuclear structure and sub-barrier fusion.** Esbensen, H. (Michigan State Univ., East Lansing, MI (USA). Cyclotron Lab.). Argonne National Lab., IL (USA). [1990]. 14p. Sponsored by U.S. DOE Energy Research; National Science Foundation. DOE Contract W-31109-ENG-38. Grant PHY87-14432. From Interface between nuclear structure and heavy-ion reaction dynamics conference; Notre Dam, IN (USA); 24-26 May 1990. Order Number DE90013679. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

The influence of nuclear structure on heavy-ion fusion and elastic scattering, at energies near and below the Coulomb barrier, is discussed within the coupled channels formalism. The coupled channels approach provides a consistent description of the enhancement of sub-barrier fusion and the energy dependence of the effective potential for elastic scattering. This is illustrated by comparison to the data for several systems. 48 refs., 4 figs.

42015 (DOE/ER/40425–249) **Nuclear structure theory: Technical progress report, September 1, 1989–June 30, 1990.** French, J.B.; Koltun, D.S. Rochester Univ., NY (USA). Jun 1990. 10p. Sponsored by U.S. DOE Energy Research. DOE Contract FG02-88ER40425. Order Number DE90013949. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

This report summarizes progress during the past ten months in the following areas of research: pion double charge exchange reactions, including a theory of the isotensor term in the pion-nucleus optical potential, and a study of meson exchange contributions to the reactions at low energies. Nuclear inelastic scattering, using quark models to calculate nuclear structure functions, and to test for sensitivity to the substructure of nucleons in nuclei. Fluctuation-free statistical spectroscopy including the theory and computer programs for interacting-particle densities spin cutoff factors, occupancies, strength sums, and other expectation values.

42016 (GSI–90-09) **Specific structure of the ^{6}He nucleus and fragmentation experiments.** Chulkov, L.V. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow (USSR). Inst. Atomnoj Ehnergii); Danilin, B.V.; Korsheninnikov, A.A.; Zhukov, M.V. Gesellschaft fuer Schwerionenforschung mbH, Darmstadt (Germany, F.R.). May 1990. 27p. Order Number DE90510599. Available from NTIS (US Sales Only), PC A03/MF A01.

Within the framework of the microscopic α+2n model, transverse momentum distributions of α-particles and neutrons as well as α-particle - neutron momentum correlation function have been calculated for the radioactive ^{6}He nucleus fragmentation. The results show that these momentum distributions reflect a specific structure of the ^{6}He nucleus, i.e. the experiments on fragmentation provide with the information on ^{6}He structure. (orig.).

42017 (GSI–90-24(prepr.)) **New physics to be learned from radioactive beams and nuclear fragmentation.** Emling, H. Gesellschaft fuer Schwerionenforschung mbH, Darmstadt (Germany, F.R.). May 1990. 12p. (CONF-900450–: Nuclear structure in the '90's, Oak Ridge, TN (USA), 23-27 Apr 1990). Available from Gesellschaft fuer Schwerionenforschung mbH, Darmstadt (Germany, F.R.).

After a description of the production of radioactive beams in the SIS-FSR-ESR concept the study of Coulomb excitation with subsequent breakup and nuclear-structure studies of extremely neutron-rich nuclei are discussed. (HSI).

42018 (IAE–4728-1) **Nuclear rotation: 4. Alignment of odd nucleon angular momentum at fast rotation of atomic nuclei. 5. Gauge field model for internal degrees of freedom of nucleus.** Kamchatnov, A.M. Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow (USSR). Inst. Atomnoj Ehnergii. 1988. 32p. (In Russian). Order Number DE90632513. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The series of works devoted to the problems of nuclear rotation are continued. IY is devoted to the theory of alignment of the odd nucleon due to the fast nuclear rotation. The dependence obtained here of angular velocity on the total angular momentum has a cusp in the point of total alignment of odd nucleon. The quantum corrections due to zero oscillations in a vicinity of stationary trajectories are calculated. In part Y the model is proposed in which an axial nuclear symmetry is considered as inner local symmetry of rotator what leads to the formal gauge field in the rotator's configuration space. 14 refs.; 2 figs.

42019 (IC–90/8) **Thermal and magnetic properties of neutron matter.** Abd-Alla, M. (International Centre for Theoretical Physics, Trieste (Italy)); Ragab, H.S.; Hassan, M.Y.M. International Centre for Theoretical Physics, Trieste (Italy). Jan 1990. 30p. Order Number DE90632603. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The Thomas-Fermi model is used to calculate the equation of state of thermal polarized neutron matter applying Seyler-Blanchard interaction. The resulting equation of state is stiff and has a small dependence on both the temperature and the spin excess parameter. We expand the Fermi integrals in powers of temperature up to second order to examine the T^2 approximation for neutron matter. It is found to be reliable up to T = 10 MeV. We also studied the ferromagnetic transition in neutron matter. We found a ferromagnetic transition at density $\rho \simeq 2\rho 0$. This ferromagnetic transition is found to have a small dependence on both the temperature and the spin excess parameter. We also studied the dependence of the effective mass and the sound velocity for polarized neutron matter on temperature. (author). 36 refs, 17 figs.

42020 (INDC(CPR)–017) **A semi-classical model for the description of angular distribution of light particles emitted in nuclear reactions.** Zhang Jingshang (Academia Sinica, Beijing, BJ (China). Inst. of Atomic Energy). International Atomic Energy Agency, Vienna (Austria). International Nuclear Data Committee. Apr 1990. 19p. Order Number DE90632616. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

A semi-classical model of multi-step direct and compound nuclear reactions has been proposed to describe the angular distributions of light particles emitted in reaction processes induced by nucleons with energies of several tens of MeV. The exact closed solution for the time-dependent master equation of the exciton model is applied. Based on the Fermi gas model, the scattering kernel for two-nucleon collisions includes the influence of the Fermi motion and the Pauli exclusion principle, which give a significant improvement in the description of the rise of the backward distributions. The angle-energy correlation for the first few steps of the collision process (multi-step direct process) yields further improvements in the description of the angular distribution. The pick-up mechanism is employed to describe the composite particle emission. This reasonable physical picture reproduces the experimental data of the energy spectra of composite particles satisfactorily. The angular distribution of the emitted composite particles is determined by an angular factor in terms of the momentum conservation of the nucleons forming the composite cluster. The generalized master equation is employed for the multi-step compound process. Thus a classical approach has been established to calculate the double differential cross sections for all kinds of particles emitted in multi-step nuclear reaction processes. (author). 19 refs, 6 figs, 1 tab.

42021 (INDC(CUB)–002) **Analysis of the low energy neutron inelastic scattering in mass range $48 \leq A \leq 64$.** Cabezas, R. (Inst. for Nuclear Science and Technology, Havana (Cuba)); Lubian, J.; Tomas, J. International Atomic Energy Agency, Vienna (Austria). International Nuclear Data Committee. Apr 1990. 16p. Order Number DE90632617. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

An analysis of low energy neutron inelastic scattering in medium-mass nuclei is made. A regional deformed optical model parameterization is proposed to describe the experimental data. This parameterization is derived from titanium, chromium, iron and nickel isotopes in the energy region of 1-3 MeV. A combined use of the coupled channel method and the statistical Hauser-Feshbach theory including corrections due to the presence of direct processes is applied. It is shown that, in the frame of this parameterization, it is possible to describe adequately experimental angular distributions, integral and total cross sections. An extrapolation to the energy region higher than 3 MeV is made. It is also shown, that this parameterization can be extended to other neighbour nuclei like zinc isotopes ^{64,66,68}Zn. (author). 41 refs, 44 figs.

42022 (INP–1370/PL) **Proceedings of 22. Zakopane school on physics, Zakopane, Poland, 1-15 May 1987. Part 1: Selected topics in nuclear structure.** Broda, R.; Stachura, Z. (eds.). Institute of Nuclear Physics, Cracow (Poland); Uniwersytet Jagiellonski, Cracow (Poland). 1987. 454p. (CONF-8705201–: 22. Zakopane school of physics, Zakopane (Poland), 1-8 May 1987). Order Number DE90632511. Available from NTIS (US Sales Only), PC A20/MF A01; OSTI; INIS.

The most important subject of the lectures is high-spin physics which progress is due to heavy-ion beams and development of multi-detector measurement technics. Super deformed phenomena in nuclei are discussed in detail. The heavy ion reaction mechanism data are obtained mostly by means of gamma spectroscopic techniques. (M.F.W.).

42023 (INP–1384/PL) **Oscillations of the quark-gluon plasma near equilibrium.** Bialas, A. (Uniwersytet Jagiellonski, Cracow (Poland). Inst. Fizyki); Czyz, W. Institute of Nuclear Physics, Cracow (Poland). Dec 1987. 21p. Order Number DE90632605. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The response of a longitudinal expanding (boost-invariant) quark-gluon plasma in equilibrium to a weak external chromoelectric field is investigated. The oscillatory modes of such a plasma differ substantially from the ones of the unconstrained, uniform plasma for temperatures and times characteristic for nucleus-nucleus collisions. 11 refs., 1 fig. (author).

42024 (ITP–87-119) **The effective hamiltonian of SU(3) model of even-even nuclei.** Filippov, G.F.; Avramenko, V.I. AN Ukrainskoj SSR, Kiev (Ukrainian SSR). Inst. Teoreticheskoj Fiziki. 1987. 29p. Order Number DE90632557. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

It is shown that studies of rotational excitations spectra and probabilities of quadrupole transitions of even-even nuclei can be reduced to a problem of diagonalizing the effective Hamiltonian (EH) constructed in the form of operator polynomial using the operators of total basis of the SU(3) group envelop algebra. EH is defined in the space of generator coordinates and proves to be nonhermitian operator. The rotational excitations spectrum and probabilities of quadrupole transitions of nuclei ^{24}Mg and ^{164}Er are calculated. 12 refs.; 1 fig.; 2 tabs.

42025 (ITP–87-133) **Microscopic calculation of the system Λ+^{4}He.** Noda, E.G.; Steshenko, A.I. AN Ukrainskoj SSR, Kiev (Ukrainian SSR). Inst. Teoreticheskoj Fiziki. 1987. 15p. Order Number DE90632558. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Using an algebraic version of the resonating groups method the hypernucleus $_\Lambda{}^5$He and also the Λ-particle scattering by α-particle in the energy range $0 < E_{\lambda\alpha} < 25$ MeV, are studied. It is shown that for the ΛN-potential reproducing the energy of the Λ-particle separation in $_\Lambda{}^5$He, the elastic scattering S-phase decreases monotonically with the increase in $E_{\Lambda\alpha}$ whereas the p-phase for the state $J^\pi = 3/2^+$ is of a weak resonance character. The other $\delta_{L,J}$-phases at energies not exceeding 25 MeV turned to be equal to zero. 22 refs.; 3 figs.

42026 (ITP–87-136) **The study of multichannel processes in a six-nucleon system: 2. The dynamics of reactions t(t,2n)alpha and sup 3He(sup 3He,2p)alpha at low energies.** Rybkin, I.Yu.; Vasilevskij, V.S.; Velazques, H. AN Ukrainskoj SSR, Kiev (Ukrainian SSR). Inst. Teoreticheskoj Fiziki. 1987. 17p. Order

Number DE90632626. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Within the framework of the two-channel approximation of the resonating group method with binary channels 3+3 and 4+2 the reactions t(t,α)2n and ^{3}He(^{3}He,α)2p in the low-energy region are studied. The reactions are shown to proceed mainly through the head-on collision of two ^{3}H or ^{3}He nuclei. The obtained theoretical energy dependences of the reaction cross-sections and astrophysical S-factors are in satisfactory agreement with the available experimental data. 14 refs.; 4 figs.

42027 (ITP–87-165) **On the role of polarization effects in nuclear reactions at low energies.** Levashev, V.P. AN Ukrainskoj SSR, Kiev (Ukrainian SSR). Inst. Teoreticheskoj Fiziki. 1988. 31p. Order Number DE90632627. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The influence of the electric polarizability of colliding particles on nucleosynthesis reaction cross sections at low energies is studied. It is established that the polarization effects in the reactions under consideration are negligibly small. Their contribution to the reaction cross sections is determined by the value of the polarization potential at the boundary of nuclear forces. It is shown that the conclusion made in other works about the strong influence of particle polarizability on pp- and dt-reaction cross sections, is a consequence of incorrect approximation of the initial-channel wave function. 35 refs.

42028 (JINR-D–1,2-88-652/v.1, pp. 32-40) **Interaction between the skyrmions LS potential of nuclear force and potential between the octet.** Otofuji, T. (Akita Univ. (Japan)). Joint Inst. for Nuclear Research, Dubna (USSR). 1988. (CONF-8806225–:). In *Proceedings of the 9. International seminar on high energy physics problems. V. 1.* Order Number DE90706115. Available from NTIS (US Sales Only), PC A20/MF A01; OSTI; INIS.

Investigations of the spin-orbital (LS) interaction of nuclear force in SU(2)-model are carried out. It is well-known that in LS potential is very important in nuclear force. LS potential is created by means of light π, ρ, σ and ω mesons for the pattern of meson exchange. Adiabatic potential reproduces well the property of π- and ρ-meson exchange within the Skyrme standard model. But the attraction in the intermediate region which corresponds to σ-meson exchange disappears. Adiabatic potential between the baryon octet in SU(3)-model is discussed. The advantage of Skyrme model is in the possibility to investigate systematically the properties and interactions of baryon. There are still many investigated intresting problems in baryon physics. For example interaction between nucleon and hyperon as well as problem of the existance of H-states are still open. 12 refs.; 1 fig.; 1 tab.

42029 (JINR-D–1,2-88-652/v.1, pp. 146-155) **Consequences of quark structure of hadrons and few nucleon systems.** Narodetskij, I.M. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow (USSR). Inst. Teoreticheskoj i Ehksperimental'noj Fiziki). Joint Inst. for Nuclear Research, Dubna (USSR). 1988. (CONF-8806225–:). In *Proceedings of the 9. International seminar on high energy physics problems. V. 1.* Order Number DE90706115. Available from NTIS (US Sales Only), PC A20/MF A01; OSTI; INIS.

Quark structure of light nuclei and nucleons, binding energy of triton and ^{4}He are considered within the frameworks of quark compound bag model (QCB). Multiquark states, quark structure and interaction effect at short ranges in NN scattering, parameters of different interaction potentials are discussed. Two-particle decay amplitudes, calculated in terms of QCB model in comparison with data obtained due to the analysis of ^{3}He(e, e'p) reactions and momentum distributions of protons for ^{3}He are presented. 16 refs.; 4 figs.

42030 (JINR-D–1,2-88-652/v.1, pp. 179-183) **Distribution of 6 q functions in nuclei and quark enhancement of hard processes with deuteron emission.** Kurgalin, S.D. (Moskovskij Gosudarstvennyj Univ., Moscow (USSR). Nauchno-Issledovatel'skij Inst. Yadernoj Fiziki); Chuvil'skij, Yu.M. Joint Inst. for Nuclear Research, Dubna (USSR). 1988. (In Russian). (CONF-8806225–:). In *Proceedings of the 9. International seminar on high energy physics problems. V. 1.* Order Number DE90706115. Available from NTIS (US Sales Only), PC A20/MF A01; OSTI; INIS.

^{2}H, ^{4}He, ^{16}O, ^{40}Ca, ^{80}Zr, ^{140}Yb, ^{224}112, ^{336}168 nuclei are invesigated in terms of fluctons model. Effective numbers of nuclear fluctons and deuterons are calculated. Values of complete effective numbers of low-radius deuterons and fluctons with S=1 spin and T=0 isospin are presented. Investigation results of inclusive reactions of quasi-elastic knock-out of deuterons by fast protons are discussed. 9 refs.; 1 fig.; 1 tab.

42031 (JINR-D–1,2-88-652/v.1, pp. 384-388) **Interpenetrating nuclei.** Barz, H.W. (Zentralinstitut fuer Kernforschung, Rossendorf (German Democratic Republic)); Kaempfer, B.; Lukacs, B.; Wolf, Gy. Joint Inst. for Nuclear Research, Dubna (USSR). 1988. (CONF-8806225–:). In *Proceedings of the 9. International seminar on high energy physics problems. V. 1.* Order Number DE90706115. Available from NTIS (US Sales Only), PC A20/MF A01; OSTI; INIS.

Equations of states of nuclear matter (NM) in terms of expanded hydrodynamic and thermodynamic models are suggested to be consider in order to investigate phase transitions occurring in NM. Expressions for energy-momentum tensor and entropy of anispotropic systems and evolution of phase transitions are obtained: liquid-gas, hadronic matter-quark plasma etc. 6 refs.

42032 (JINR-D–1,2-88-652/v.1, pp. 377-383) **Deuteron fragmentation at relativistic energies.** Mueller, H. (Zentralinstitut fuer Kernforschung, Rossendorf (German Democratic Republic)). Joint Inst. for Nuclear Research, Dubna (USSR). 1988. (CONF-8806225–:). In *Proceedings of the 9. International seminar on high energy physics problems. V. 1.* Order Number DE90706115. Available from NTIS (US Sales Only), PC A20/MF A01; OSTI; INIS.

Description of deuteron interaction with protons at relativistic energies in terms of impulse approximation is given. Deuteron normal wave function is used to calculate momentum distributions and invariant cross sections of d+p → p+x reactions at 9.1 GeV/c energy in deuteron rest system and d+p→p+x at 9.0 GeV/c in the laboratory system. Data obtained in earlier pp-experiments are compared with model calculations of deuteron wave function in impulse approximation. The obtained results do not contradict application of deuteron normal wave function when interpreting proton spectra measured at 9 GeV/c deuteron momentum. 14 refs.; 3 figs.

42033 (JINR-D–1,2-88-652/v.1, pp. 389-400) **Dynamics of relativistic nuclei interaction.** Amelin, N.S.; Gudima, K.K.; Toneev, V.D. Joint Inst. for Nuclear Research, Dubna (USSR). 1988. (In Russian). (CONF-8806225–:). In *Proceedings of the 9. International seminar on high energy physics problems. V. 1.* Order Number DE90706115. Available from NTIS (US Sales Only), PC A20/MF A01; OSTI; INIS.

Kinetic model of nucleus-nuclear collisions at relativistic energies, which takes into account production and decay of independent quark-gluon strings and peculiarity of space-time pattern of hadron interaction is suggested. It is shown that energy local density in the region of fm^3 several tens volume may be essentially more than ϵ_{cr} critical value but here interaction is essentially nonequilibrium while period of such system state is rather short. It is shown that the simplest (quasi)linear variant of the model agrees qualitatively with the experiment by one of the most important characteristics carrying information about nearness of excited state to the critical one. Importance of nonlinear effects to achieve quantitative agreement of model prediction with the experiment is pointed out. 13 refs.; 5 figs.

42034 (JINR-D–1,2-88-652/v.1, pp. 401-415) **Breaking property and pionic radiation in relativistic nuclear collisions.** Mishustin, I.N. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow (USSR). Inst. Atomnoj Ehnergii); Russkikh, V.N.; Satarov, L.M. Joint Inst. for Nuclear Research, Dubna (USSR). 1988. (In Russian). (CONF-8806225–:). In *Proceedings of the 9. International seminar on high energy physics problems. V. 1.* Order Number DE90706115. Available from NTIS (US Sales Only), PC A20/MF A01; OSTI; INIS.

New version of biliquid hydrodynamic model (BHM), where pion radiation is taken into account along with beam mutual braking is developed in this paper. Numerical solution for BHM equations in three-dimensional geometry was conducted to describe collisions

of ultrarelativistic nuclei. Space-time pattern of the process and properties of forming high-excited hadron matter were investigated using O+Au reactions at 13.6, 60 and 200 GeV/nucleon energies as an example. It is pointed out that at the increase of collision energy the number of producting pions increases rapidly. Energy density at 60 and specially 200 GeV/nucleon energies in pion cloud becomes sufficient for transition into quark-gluon plasma state. But lifetime of high energy density state is very short (at least, for baryon subsystem) of the order of 1 fm/c. Probability of phase transition under such conditions is rather problematic and requires special study. 19 refs.; 7 figs.; 1 tab.

42035 (JINR-D–1,2-88-652/v.1, pp. 416-427) **Mixed phase of QCD matter in relativistic nuclear collisions.** Gorenshtejn, M.I. (AN Ukrainskoj SSR, Kiev (Ukrainian SSR). Inst. Teoreticheskoj Fiziki). Joint Inst. for Nuclear Research, Dubna (USSR). 1988. (In Russian). (CONF-8806225–:). In *Proceedings of the 9. International seminar on high energy physics problems. V. 1.* Order Number DE90706115. Available from NTIS (US Sales Only), PC A20/MF A01; OSTI; INIS.

Aim of the report is to discuss possibilities of formation and experimental investigation of the matter QCD mixed phase in relativistic nuclear collisions at 1 GeV/nucleon$<E_{lab}<$10 GeV/nucleon intermediate energies. Experiments with heavy ion reactions using Dubna nucleotron just in this energy range are planned in the nearest future. Phase diagram of strong-interacting matter is considered. Calculation results for compression collision adiabats in relativistic nuclear collisions are presented. Possible experimental signals of mixed phase are discussed. Main conclusions of the report are as follows. Formation of matter QCD mixed phase may be expected in central collisions of heavy nuclei with E_{lab}/A=(3-7) GeV/nucleon. Instability of collision impact compression mode production of quark clusters with high strangeness and strong fluctuations of the observed properties of secondary hadrons in separate events may serve as specific signals of its formation. 21 refs.; 4 figs.

42036 (JINR-E–2-89-437) **Internuclear cascades at high energies.** Barashenkov, V.S.; Polanski, A.; Sosnin, A.N. Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Computing Techniques and Automation. 1989. 16p. Order Number DE90632632. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Submitted to Acta Phys. Pol.

Methods of Monte-Carlo simulation of particle cascades produced in matter samples by high energy hadrons and nuclei are discussed. It appears that a hybrid model based on noncoherent intranuclear cascade mechanism for particles and nuclei with energies under several GeV/nucleon and quark-gluon string approach at high energies is in good agreement with experiment. Decays of excited residual nuclei are calculated by means of evaporation cascade mechanism in both cases. A version of the model is developed, which could be applied at energies up to 100 GeV/nucleon. More accurate calculation procedure for inelastic hadron- and ion-nucleus interactions allows one to spread its application to higher energies - up to 10^3-10^4 GeV/nucleon. 27 refs.; 5 figs.; 4 tabs.

42037 (JINR-E–4-88-906) **A phenomenological unified description of the ground band energy levels of rotational nuclei.** Drenska, S.B. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics); Georgieva, A.I.; Ivanov, M.I.; Mavrodiev, S.S.; Rajchev, P.P.; Rusev, R.P. Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics. 1988. 7p. Order Number DE90632562. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

On the basis of a symplectic classification of nuclei a phenomenological five-parameter formulae for a unified description of the low-lying excited states of the ground bands of the well deformed even-even nuclei has been derived. The theoretical results are compared with the experimental data for 328 levels of 70 nuclei. 7 refs.; 2 tabs.

42038 (JINR-E–4-89-187) **Microscopic boson approach to nuclear collective motion.** Kuchta, R. Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics. 1989. 31p. Order Number DE90632563. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Submitted to Nucl. Phys., A.

A quantum mechanical approach to the maximally decoupled nuclear collective motion is proposed. The essential idea is to transcribe the original shell-model Hamiltonian in terms of boson operators, then to isolate the collective one-boson eigenstates of the mapped Hamiltonian and to perform a canonical transformation which eliminates (up to the two-body terms) the coupling between the collective and noncollective bosons. Unphysical states arising due to the violtion of the Pauli principle in the boson space are identified and removed within a suitable approximation. The method is applied to study the low-lying collective states of nuclei which are successfully described by the exactly solvable multilevel pairing Hamiltonian (Sn, Ni, Pb). 75 refs.; 8 figs.

42039 (JINR-E–4-89-267) **The nucleon-nucleon correlations and the integral characteristics of the potential distributions in nuclei.** Knyaz'kov, O.M. (Leningradskij Gosudarstvennyj Univ., Leningrad (USSR). Nauchno-Issledovatel'skij Fizicheskij Inst.); Kukhtina, I.N. Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Computing Techniques and Automation. 1989. 7p. Order Number DE90632564. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

Submitted to Izv. Akad. Nauk SSSR, Ser. Fiz.

The integral characteristics of the potential distribution in nuclei, namely the volume integrals, moments and mean square radii are studied in the framework of the semimicroscopic approach to the interaction of low energy nucleons with nuclei on the base of the exchange nucleon-nucleon correlations and the density dependence of effective forces. The ratio of the normalized multipole moments of potential and matter distributions is investigated. The energy dependence of the integral characteristics is analyzed. 15 refs.; 2 tabs.

42040 (JINR-E–4-89-330) **Where do we stand with calculations of the ($2\nu2\beta$)-decay rates.** Simkovic, F. (Komenskeho Univ., Bratislava (Czechoslovakia)); Gmitro, M. Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics. 1989. 6p. Order Number DE90632688. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

Submitted to Phys. Lett., B.

An alternative approach to the calculation of the double-beta-decay amplitudes is discussed, which includes neither the evaluation of the intermediate-nucleus spectrum nor the closure approximation. It is shown that the ($2\nu2\beta$) amplitudes are subject to a strong suppression due to the structure of nuclear weak currents. Reliable calculations should be based on effective Hamiltonians which include exchange currents. 9 refs.

42041 (JINR-E–4-89-443) **Unitary scattering theory of low-energy pions by light nuclei: formalism.** Khankhasaev, M.Kh. Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics. 1989. 18p. Order Number DE90632633. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Submitted to Nucl. Phys., A.

The unitary approach to the description of pion-nucleus scattering (UST) based on the method of evolution of the system with respect to the coupling constant is presented. The basic equations are formulated for the direct calculation of the pion-nucleus phase shifts. A new derivation of the unitary multiple scattering series which makes the UST formalism similar to the standard Watson theory is given. An iterative solution of these equations rapidly convergent at low energies (below 70 meV) is considered. The role of the second-order effects in the pion-nucleus scattering at low energies are discussed. 16 refs.; 1 tab.

42042 (JINR-E–4-89-444) **Unitary scattering theory of low-energy pions by light nuclei: applications.** Khankhasaev, M.Kh. Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics. 1989. 23p. Order Number DE90632634. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Submitted to Nucl. Phys., A.

The results of a unified description of both the low-energy scattering data and the pionic atom data for ^{4}He, ^{12}C and ^{16}O within the framework of the unitary scattering-approach are presented. Strong influence of the pion absorption on the elastic scattering channel at low energies is demonstrated. It is shown that a unique

set of parameters of the absorption correction provides good quantitative description of the pion elastic scattering data at energies up to 50 MeV. 48 refs.; 13 figs.; 6 tabs.

42043 (JINR-R–1-89-247) **Some methodological problems of the investigation of two-proton correlations in the region of small relative momenta.** Pluta, J. Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy. 1989. 12p. (In Russian). Order Number DE90632635. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Some methodical problems concerning the investigation of the size of proton emission volume by means of two-particle correlation analysis in the region of small relative momenta are considered. The simulation of real experimental conditions has been performed for proton correlation characteristics. The method is proposed to determine the size of the proton emission volume taking into account the real experimental conditions. 25 refs.; 8 figs.

42044 (JINR-R–4-89-109) **Two- and four-nucleon clusters in the light and heavy nuclei.** Trajdos, M. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics); Zajac, K. Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics. 1989. 18p. (In Russian). Order Number DE90632565. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Submitted to Izv. Akad. Nauk SSSR, Ser. Fiz.

The effects induced by the interplay isovector and isoscalar components of the residual nuclear forces were studied in the model based on six bosons: s_μ^+ with $J^\pi=0^+$, T=1, μ=0, $\pm$ and r_μ^+ with $J^\pi=1^+$, μ=0, $\pm$1, T=0. Spectra, r-boson and α-cluster structure of the eigenstates, intensities of (p,t) reaction and α elastic scattering are shown for the $^{26-28}$Al. The conclusions are based on the calculations for the nuclei with $8 \leq Z \leq 16$ $^{40-46}$Ca, $^{42-48}$Ti, $^{154-166}$Dy and N=92, $56 \leq Z \leq 58$. 33 refs.; 9 figs.; 1 tab.

42045 (JINR-R–4-89-179) **The decay of giant resonances.** Voronov, V.V. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics); Ponomarev, V.Yu.; Silvera, M.P. Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics. 1989. 8p. (In Russian). Order Number DE90632566. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

Submitted to Yad. Fiz.

The γ-decay partial widths of the giant quadrupole and hexadecapole-resonances in ^{90}Zn and ^{208}Pb to low-lying states are calculated within the quasiparticle-phonon model. It can be concluded that the complex configurations of the wave function are rather important for a correct description of decay properties of highly excited nuclear states. It is shown that due to the core polarization the decay of the isovector resonances is more intensive compared to the isoscalar ones. 23 refs.; 3 figs.; 1 tab.

42046 (JINR-R–4-89-325) **Systematics and analysis of the odd ytterbium nuclei properties with A=163-173: Probability of the interband gamma-transitions.** Adam, J. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems); Wawryszczuk, J.; Gromov, K.Ya.; Nesterenko, V.O.; Alikov, B.A.; Badalov, Kh.N.; Muminov, T.M. Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems. 1989. 19p. (In Russian). Order Number DE90632567. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The reduced probabilities of interband M1- and E2-transitions and coefficients of mixing δ(E2/M1) in odd ytterbium nuclei with A=163-173 are calculated and analyzed within the nonadiabatical rotational model (NRM) with taking into account the quasiparticle-phonon interaction. The probability of E1-transitions is considered within NRM without quasiparticle-phonon interaction. Results of calculations are compared with experimental data. The structure of matrix elements of the considered transitions is analyzed in detail. 29 refs.; 3 figs.; 7 tabs.

42047 (JINR-R–7-89-346) **Quark-Gluon string model and ultrarelativistic heavy ion collisions.** Amelin, N.S. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems); Toneev, V.D.; Gudima, K.K. Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems. 1989. 18p. (In Russian). Order Number DE90632636. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Submitted to Yad. Fiz.

Monte-Carlo version of quark-gluon string model for inelastic nucleus-nucleus collisons at ultrarelativistic energies is developed. The similarities and distinctions of this model with other Monte-Carlo models are discussed. The model results for nuclear interactions at 200 GeV per nucleon are compared withexperimental data. 22 refs.; 15 figs.

42048 (KFKI–1989-56/A) **Two pion correlation from SPACER.** Csoergoe, T. (Hungarian Academy of Sciences, Budapest (Hungary). Central Research Inst. for Physics); Zimanyi, J.; Bondorf, J.; Heiselberg, H.; Pratt, S. Hungarian Academy of Sciences, Budapest (Hungary). Central Research Inst. for Physics. Dec 1989. 23p. Order Number DE90632638. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Submitted to Phys. Lett., B (NL).

The correlation function for neutral and negative pions produced in ultrarelativistic heavy ion collisions was calculated without free parameters based on a space-time version of the LUND model, called SPACER: Simulation of Phase space distribution of Atomic nuclear Collisions in Energetic Reactions. This method includes the effect of Bose correlations for the emitted pion pair. Effects arising from correlations between space-time and momentum space distributions are investigated. The results are compared to the data of two different experiments. The role and interpretation of the chaocity parameter are discussed. (D.G.) 14 refs.; 4 figs.

42049 (KFKI–1989-65/A) **Macroscopic dynamics of thermal nuclear excitations.** Bastrukov, S.I. (Eoetvoes Lorand Tudomanyegyetem, Budapest (Hungary). Atomfizikai Tanszek); Deak, F.; Kiss, A.; Toto, M. di; Seres, Z. Hungarian Academy of Sciences, Budapest (Hungary). Central Research Inst. for Physics. Nov 1989. 21p. Order Number DE90632570. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Submitted to Nucl. Phys., A (NL).

The concept of kinetic temperature as a local dynamical variable of thermal nuclear collective motion is formulated using long-mean-free-path approach based on the Landau-Vlasov kinetic equation. In the Fermi drop model the thermal fluid dynamics of the spherical nucleus is analyzed. It is shown that in a compressible Fermi liquid the temperature pulses propagate in the form of spherical wave in phase with the acoustic wave. The thermal and compressional excitations are caused by the isotropic harmonic oscillations of the Fermi sphere in momentum space. (author) 25 refs.; 2 figs.

42050 (KFKI–1990-03/A) **Description of the nuclear stopping process within anisotropic thermo-hydrodynamics.** Kaempfer, B. (Zentralinstitut fuer Kernforschung, Rossendorf (German Democratic Republic)); Barz, H.W.; Lukacs, B.; Wolf, G. Hungarian Academy of Sciences, Budapest (Hungary). Central Research Inst. for Physics. Jan 1990. 12p. Order Number DE90632607. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

A generalized hydrodynamics is presented which takes into account the anisotropy of nucleon momentum distribution. The anisotropy is to be assumed of a cylindrical symmetry and is characterized by an anisotropy 3-vector, an extra extensive quantity (dynamic beam pressure) and an extra intensive (related to the relative velocity of fluids in the two-fluid model). A special plane-symmetric example is treated and solved numerically to show the nuclear stopping process in heavy ion collisions. The limiting cases give the old shock wave approximation and the unpenetrating two-fluid model. The temporal development and spatial distribution of the total and relative velocities and that of the dynamic pressure (playing the role of the Neumann-Richtmyer artificial viscosity) are discussed. (D.G.) 10 refs.; 2 figs.

42051 (LA–11877-C, pp. 59-66) **n-p bremsstrahlung in heavy ion collision processes.** Blann, M. (Lawrence Livermore National Lab., CA (USA)). Los Alamos National Lab., NM (USA). Jul 1990. (CONF-900179–Summs: Los Alamos National Laboratory (LANL) workshop on n-p Bremsstrahlung, Los Alamos, NM (USA), 25-26 Jan 1990). In *Lectures from the workshop on nucleon-nucleon bremsstrahlung, January 25-26, 1990.* Order Number DE90012740. Available from NTIS, PC A95/MF A01.

The goal of this presentation is to summarize the current status of the interpretation of energetic γ-rays in heavy ion collisions via the n-p-bremsstrahlung mechanism. An essential element of the topic is a transport equation to approximate the fast non-equilibrium nucleon-nucleon cascade/emission stage of the heavy ion reactions. It is during this stage that it is expected the np-p-bremsstrahlung processes will produce energetic photons. The author shall begin with a very brief description of the Boltzmann master equation (BME) model which will be used as the transport code, deferring to earlier works for a more complete description, and present but a single representative comparison with an experimental neutron emission spectrum. The author shall then summarize the status of the elementary n-p-γ cross section needed to extend the transport code to photon emission in heavy ion reactions, and summarize the status of these comparisons with data. 29 refs.

42052 (LBL–28986) **Pion correlations in relativistic heavy ion collisions at Heavy Ion Spectrometer Systems (HISS).** Christie, W.B. Jr. Lawrence Berkeley Lab., CA (USA). May 1990. 146p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00098. Order Number DE90014181. Available from NTIS, PC A08/MF A01; OSTI; INIS; GPO Dep.

Thesis submitted to the Univ. of California, Davis.

This thesis contains the setup, analysis and results of experiment E684H "Multi-Pion Correlations in Relativistic Heavy Ion Collisions". The goals of the original proposal were: (1) To initiate the use of the HISS facility in the study of central Relativistic Heavy Ion Collisions (RHIC). (2) To perform a second generation experiment for the detailed study of the pion source in RHIC. The first generation experiments, implied by the second goal above, refer to pion correlation studies which the Riverside group had performed at the LBL streamer chamber. The major advantage offered by moving the pion correlation studies to HISS is that, being an electronic detector system, as opposed to the Streamer Chamber which is a visual detector, one can greatly increase the statistics for a study of this sort. An additional advantage is that once one has written the necessary detector and physics analysis code to do a particular type of study, the study may be extended to investigate the systematics, with much less effort and in a relatively short time. This paper discusses the Physics motivation for this experiment, the experimental setup and detectors used, the pion correlation analysis, the results, and the conclusions possible future directions for pion studies at HISS. If one is not interested in all the details of the experiment, I believe that by reading the sections on intensity interferometry, the section the fitting of the correlation function and the systematic corrections applied, and the results section, one will get a fairly complete synopsis of the experiment.

42053 (WHC-EP–0346) **Automated calculation of alpha energy spectra.** Troyer, G.L. Westinghouse Hanford Co., Richland, WA (USA). Jun 1990. 21p. Sponsored by U.S. DOE Office of Environmental Restoration and Waste Management. DOE Contract AC06-87RL10930. Order Number DE90014064. Available from NTIS, PC A03/MF A01; OSTI; Order software packages from National Energy Software Center, Argonne National Laboratory, 9800 South Cass Avenue, Argonne, IL 60439. Order documentation without complete package from NTIS.; GPO Dep.

The external and operating specifications for a general alpha energy analysis data reduction program are presented in this document. A brief description of the methodology is given to identify the main features and reasons for use. Specifications for the supporting data files are also presented. Brief operating step procedures are presented as appendixes.

42054 Production of soft dileptons in the quark-gluon plasma. Braaten, E. (Department of Physics and Astronomy, Northwestern University, Evanston, IL (USA)); Pisarski, R.D.; Yuan, T.C. *Physical Review Letters (USA),* 64(19): 2242-2245 (7 May 1990). DOE Contract AC02-76ER02289.

The production rate for soft dileptons in a hot quark-gluon plasma is computed to leading order in the QCD coupling constant through a systematic resummation of perturbation theory. The partial rate from the annihilation and decay of soft quarks and antiquarks exhibits unexpected structure—sharp peaks due to Van Hove singularities. These peaks are overwhelmed by the partial rate from processes involving hard quarks and gluons. The total rate for soft dileptons is larger than the naive one-loop prediction by orders of magnitude.

6540 Radiation and Shielding Physics

Refer also to citation(s) 41344

42055 (INDC(CUB)–003) **Energy and time spreads of a particle beam used in APM technique.** Capote, R. (Nuclear Science and Technology Inst., Havana (Cuba)); Monne, G.; Sandin, C.; Sarris, P. International Atomic Energy Agency, Vienna (Austria). International Nuclear Data Committee. Apr 1990. 19p. Project CUB/1/005. Order Number DE90632499. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

A Monte Carlo code has been developed to simulate neutron and alpha production in the time correlated associated particle method (TCAPM). The atomic and molecular composition of the deuterium beam, tritium ratio in the target, slowing-down and straggling of deuterons as well as the angular dependence of emitted neutrons and alpha particles are both taken into account in these calculations. The following physical characteristics are obtained: mean energy of detected alpha particles and their spread, mean time of flight and its spread values for alpha particles, alpha and associated neutron spectra as well as neutron spatial cone distribution. (author). 11 refs, 10 figs, 4 tabs.

42056 (IYaF–89-16) **EMSH program for calculating electron and photon transport through a matter at energies of 10 keV-1TeV.** Tayurskij, V.A. AN SSSR, Novosibirsk (USSR). Inst. Yadernoj Fiziki. 1989. 49p. (In Russian). Order Number DE90632507. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The EMSH program (Electro-Magnetic Shower) for the calculation of 1 keV-1 TeV electron and photon transport through a substance is described. The program is written in FORTRAN for the ES computers. Electron and positron bremsstrahlung, e^-e^-- and e^+e^- scattering, positron annihilation, production of e^+e^--pairs by photons, photon. Compton scattering, photoelectric effect, photon Rayleigh scattering are taken into account during calculations. The cross sections of these processes are assigned with the 3-10% accuracy. Energy losses for atom ionization and excitation and bremsstrahlung, as well as multiple scattering are taken into account for charged particles. The program is used to calculate electron conversion into positrons, to estimate accelerator radiation background, to simulate electromagnetic showers in electromagntic calorimeters. 37 refs.; 15 figs.

42057 (JINR–18-89-113) **Thermal neutron absorption cross section of small samples.** Nghiep, T.D. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions); Vinh, T.T.; Son, N.N.; Vuong, T.V.; Hung, N.T. Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions. 1989. 5p. (In Russian). Order Number DE90632500. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

A modified steady method for determining the macroscopic thermal neutron absorption cross section of small samples 500 cm^3 in volume is described. The method uses a moderating block of paraffin, Pu-Be neutron source emitting $1.1x10^6$ $n.s.^{-1}$, SNM-14 counter and ordinary counting equipment. The interval of cross section from 2.6 to $1.3x10^4$ (10^{-3} cm^2g^{-1}) was measured. The experimental data are described by calculation formulae. 7 refs.; 4 figs.

42058 (SAND–89-2211) **Results guide to CEPXS/ONELD: A one-dimensional coupled electron-photon discrete ordinates code package: Version 1.0.** Lorence, L.J. Jr. (Sandia National Labs., Albuquerque, NM (USA)); Morel, J.E.; Valdez, G.D. Sandia National Labs., Albuquerque, NM (USA). Jul 1990. 158p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC04-76DP00789. Order Number DE90014748. Available from NTIS, PC A08/MF A01 - OSTI; GPO Dep.

CEPXS/ONELD is a discrete ordinates code package for one-dimensional coupled electron-photon transport over the energy range of 100 MeV to 1.0 keV. In this Results Guide, CEPXS/ONELD predictions are compared to the predictions of Monte Carlo codes and to experiment. These comparisons are made for a variety of quantities, including energy deposition, charge deposition

and electron current spatial profiles as well as electron and photon spectra. Sensitivity studies are presented that show how the numerical approximations of CEPXS/ONELD can affect the accuracy of predictions. Guidelines for the efficient and accurate use of the code package are given. All examples involve one-dimensional planar geometry and non-adjoint transport. 35 refs.

6550 Medical Physics

Refer also to citation(s) 41702

42059 (CLM-R–299) **Dosimetric data for FISPACT.** Smith, K.R. Commission of the European Communities, Abingdon (UK). JET Joint Undertaking. Apr 1990. 33p. Order Number DE90633889. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

A complete set of dosimetric data has been compiled for all the radionuclides included in the data libraries associated with the fusion activation code FISPACT. Data contained in the existing literature have been used wherever possible. However, for some radionuclides it was necessary to estimate the appropriate values. The methodology adopted for estimation is also presented. (author).

42060 (JAERI-M–89-212) **Health physics in JAERI No. 31: April 1, 1988 - March 31, 1989.** Japan Atomic Energy Research Inst., Tokyo (Japan). Dec 1989. 359p. (In Japanese). Order Number DE90508083. Available from NTIS (US Sales Only), PC A16/MF A01.

In the annual report No. 31 (fiscal 1988) are described the activities of health physics including radioactive waste management in Tokai Research Establishment, Takasaki Radiation Chemistry Research Establishment, Oarai Research Establishment, Mutsu Establishment and Nuclear Ship Mutsu. There were no occupational exposure exceeding the maximum permissible dose and no release of radioactive gaseous and liquid wastes beyond the release limits specified according to the regulations. In the environment there were observed no abnormal radioactivity due to the facilities. Technology developments were made as in the previous years for improving the techniques and methods in monitoring of individuals, facilities and environment, radiation measurement instrumentation and also in waste management and decontamination. The following works were made in the researches of radiation dosimetry, body radioactivity, airborne radioactivity and waste disposal. For radiation dosimetry: 4π directional dependency of external effective dose equivalent, development of mathematical phantom and Monte Carlo dose evaluation code, dose distribution analysis code, phantom used for calibration of personal neutron dosimeter, and extended sources with polyethylene ion-exchange membrane. For body radioactivity: study on plutonium chest counting, and radiosensitivity of chromosomes of rabbit lymphocytes. For airborne radioactivity: tritium oxide permeability of membranes used for protective appliances, and tritium gas conversion to tritiated water. For waste disposal: safety verification test of rational disposal of very low-level radioactive solid wastes, and effects of residual radioactivity on scientific and industrial instruments. (J.P.N.).

42061 (JAERI-M–90-022) **Table of committed effective dose equivalent etc. per unit intake of actinide elements conformable to radiation protection regulations: Supplement to JAERI-M 87-172.** Kawai, Katsuo (Japan Atomic Energy Research Inst., Tokai, Ibaraki (Japan). Tokai Research Establishment); Togawa, Orihiko; Yamaguchi, Yukichi; Suga, Shinichi; Numakunai, Takao. Japan Atomic Energy Research Inst., Tokyo (Japan). Feb 1990. 20p. (In Japanese). Order Number DE90508042. Available from NTIS (US Sales Only), PC A03/MF A01.

Committed effective dose equivalent and, if ALI is determined by non-stochastic effect on a particular organ or tissue, the relevant committed tissue dose equivalent per unit intake by inhalation or ingestion, were previously reported in JAERI-M 87-172, 'Table of Committed Effective Dose Equivalents According to the ICRP Publication 30' (October 1987). However, the values of committed effective dose equivalent etc. for parts of radionuclides presented in the report are not consistent with those values that were adopted as a basis for calculation of ALI's given in the regulations now in force. The reason is that the current regulations, noticed later than the publication of JAERI-M 87-172, have incorporated the recommendation of ICRP Publication 48, 'The Metabolism of Plutonium and Related Elements'. In this report, for the purpose of assisting persons in practicing conformable dose assessment to current regulations, tabulation of committed effective dose equivalents and, if ALI is determined by non-stochastic effect on a particular organ or tissue, the relevant committed tissue dose equivalent per unit intake by inhalation and ingestion, is presented for plutonium and other actinides dealt with by ICRP Publication 48. (author).

42062 (JINR–16-89-353) **Measurement of dosimetric parameters of therapeutic proton beams.** Votochkova, I. (Ceskoslovenska Akademie Ved, Prague (Czechoslovakia). Ustav Radiologicke Dozimetrie); Spurny, F.; Zorin, V.P.; Molokanov, A.G. Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems. 1989. 7p. (In Russian). Order Number DE90633891. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

Absorbed dose rate measuremets in proton beams of clinico-physical complex of JINR Laboratory of Nuclear Problems are described. Two ionization chambers, used for measurements, were preliminary caibrated with respect to primary standard of the Prague Institute of Radiation Dosimetry ^{60}Co - source. Two clinical dosemeters KD-27012 were calibrated at proton beams. Using of ROCUS-M distant gamma unit as calibrating plant is grounded. 14 refs.; 2 figs.; 4 tabs.

42063 (JINR-R–16-88-531) **Method of dose determination in high energy particle therapy beams.** Zielczynski, M. Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems. 1988. 24p. (In Russian). Order Number DE90633890. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The cavity theory is modified to obtain such a formula for determination of absorbed dose using ionization chamber in high energy particle beams, which (formula) contains only one factor dependent on ionization chamber wall materials, and this factor can be determined experimentally. The energy expended to creation an ion pair and the restricted stopping power ratio are correlated with a recombination index of radiation quality, which also can be found experimentally in the investigated radiation beams. Accuracy of the absorbed dose determination in therapy beams of particles with energy of some hundreds MeV, by means of the method proposed, is equal to about 5%. 39 refs.; 3 figs.; 1 tab.

42064 (OEFZS-A–1629) **Radiation protection control report for the Research Centre Seibersdorf for the year 1989.** Mueck, K.; Steger, F.; Hefner, A. Oesterreichisches Forschungszentrum Seibersdorf GmbH (Austria). Inst. fuer Strahlenschutz. Feb 1990. 64p. (In German). (ST–177/90). Available from the Austrian Research Centre Seibersdorf, A-2444 Seibersdorf (Austria).

Limited Distribution.

The radiation protection control report for the Research Centre Seibersdorf comprises the results of all measurements which have been performed during the year 1989 by the radiation protection control department to protect the employees and the environment of the Research Centre Seibersdorf. Personnel monitoring was carried out by TL-dosimetry to control the external dose, by body counting and excretion analysis for the surveillance of internal exposure according to the Austrian Radiation Protection Law. Monitoring of working places and laboratories was performed by external dose rate measurements, by smear tests and by measurements of the activity concentration in air. The radioactivity emissions from the ASTRA-reactor, the SAL, the waste-incineration plant and other institutes as well as the radioactive effluents from the water treatment plant were monitored. The environmental surveillance was supplemented by measurements of the activity content of surface air, tap- and surface water, soil and vegetation samples. The net dose amounted to less than 1% of the annual limit of 50 mSv for occupationally exposed workers. For a collective of 345 employees actually occupied in radiation areas the average annual dose including natural background radiation amounted 1,31 mSv/a (131 mrem/a) which is also less than 1% of the maximum value. 24 tabs., 14 figs. (Authors).

6560 Condensed Matter Physics

Refer also to citation(s) 40976, 40988, 41026, 41096, 41254, 41796, 41800, 41805

42065 (AD-A–220460/0/XAB) **Surface physics instrumentation. Final report, 1 December 1988-30 November 1989.** Seidl, M.; Isenberg, J.; Kim, S.I.; Souzis, A.E. Stevens Inst. of Tech., Hoboken, NJ (USA). Plasma and Surface Physics Lab. 29 Jan 1990. 25p. Available from NTIS, PC A03/MF A01.

This report describes the considerable improvements in surface physics instrumentation at the Plasma and Surface Physics Laboratory made possible grant. The following three add-on instruments were purchased: Scanning Tunneling Microscope (STM), Low Energy Electron Diffractometer (LEED), Quadrupole Mass Spectrometer (QMS). A unique design has been chosen for STM. Starting with a non-vacuum STM (Nanoscope II), a vacuum compatible STM head was designed. The head uses the Nanoscope computer and can be attached to either of our UHV chambers. All the acquired instruments have been integrated with the two surface instrumentation systems existing in the laboratory. The Surface Analysis System is equipped with Auger Electron Spectroscopy (AES), Ultra Violet Photoelectron Spectroscopy (UPS), Work Function Measuring Station and Sample Transfer System for the STM. The Ion Beam System is equipped with the Quadrupole Mass Spectrometer Ion Mass Spectroscopy used for Spectroscopy, LEED, two Ion Beam Lines and Sample Transfer System for the STM.

42066 (CONF-9009125–1) **Electron transport in fast dielectric liquids at high applied electric fields.** Faidas, H. (Tennessee Univ., Knoxville, TN (USA). Dept. of Physics); McCorkle, D.L.; Christophorou, L.G. Oak Ridge National Lab., TN (USA). [1990]. 6p. Sponsored by U.S. Department of Defense; U.S. DOE Energy Research. DOE Contract AC05-84OR21400. From 10. international conference on conduction and breakdown in dielectric liquids; Grenoble (France); 10-14 Sep 1990. Order Number DE90009815. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

The drift velocity, w, of excess electrons as a function of the applied uniform electric field, E, in liquid 2,2-dimethylpropane (TMC), tetramethylsilane (TMS), tetramethylgermanium (TMG), tetramethyltin (TMT), 2,2,4,4-tetramethylpentane (TMP) and in mixtures of TMS with TMP (mole ratio M = 1.31/1) and n-pentane (M = 102/1, 17/1, and 5.6/1) has been measured for E-values up to $\sim 10^5$ V cm^{-1}. The thermal electron mobility in the above liquids is 71.5, 119.3, 114.7, 85.7, 31.8, 39.1, 118, 85, and 47.6 cm^2 s^{-1} V^{-1}, respectively. 8 refs., 2 figs., 1 tab.

42067 (DOE/ER/45233–5) **Studies of ultrathin magnetic films and particle-surface interactions with spin-sensitive electron spectroscopies: Progress report, 1 December 1989–31 October 1990.** Walters, G.K.; Dunning, F.B. Rice Univ., Houston, TX (USA). Jul 1990. 6p. Sponsored by U.S. DOE Energy Research. DOE Contract FG05-86ER45233. Order Number DE90013953. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

Research during the current grant year has focused on: Investigation of the probing depth in electron scattering from epitaxially grown paramagnetic films by means of Spin-Polarized Electron Energy Loss Spectroscopy (SPEELS). Studies of the effect of alkalation on the dynamics of metastable He(2^3S) deexcitation at surfaces utilizing Spin-Polarized Metastable Deexcitation Spectroscopy (SPMDS).

42068 (FTINT–49-88) **Hard-magnetic surface layer effect on the erbium orthoferrite plate domain structure in the region of gradual spin reorientation.** Belyaeva, A.I.; Vojtsenya, S.V.; Yur'ev, V.P. AN Ukrainskoj SSR, Kharkov (Ukrainian SSR). Fiziko-Tekhnicheskij Inst. Nizkikh Temperatur. 1988. 24p. (In Russian). Order Number DE90631767. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Rearrangement of domain structures in the erbium orthoferrite plates with hard-magnetic surface layer is investigated during gradual spin reorientation. This phenomenon is explained by means of the proposed physical models. It is shown that in these plates an approach to the temperature interval of spin reorientation causes a decrease in the density of energy of domain walls separating the internal and surface domains. This decrease results in transition to the domain structure which are close to equilibrium ones inside the crystal. 30 refs.; 4 figs.

42069 (IC–89/419) **Lattice dynamical appraisal of the anisotropic Debye-Waller factors in graphite lattice.** Haridasan, T.M. (International Centre for Theoretical Physics, Trieste (Italy)); Sathyamurthy, G. International Centre for Theoretical Physics, Trieste (Italy). Dec 1989. 8p. Order Number DE90631768. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

The Debye-Waller factors in graphite for the atomic motions within the basal plane and also across the basal planes have been calculated using the various lattice dynamical models available to date and a critical comparison is made with the existing experimental data from X ray and neutron scattering studies. The present study reveals the need for further investigation on the nature of atomic motion across the basal planes. (author). 15 refs, 1 tab.

42070 (IC–90/6) **A model of anelastic relaxation associated with polygonization boundary.** Yan, S.C. International Centre for Theoretical Physics, Trieste (Italy). Jan 1990. 18p. Order Number DE90631766. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

A model of anelastic relaxation associated with polygonization boundary is proposed in order to explain internal friction peaks and other experimental phenomena observed recently. The model, which is referred to as vacancy-thermal jog model, shows that under conditions of high temperature and low applied stress with lower frequencies of vibration, thermal jog pairs are generated on dislocation segments of the boundaries. These jogs are in saturation with vacancies in the vicinity of them, and the vacancy current due to the concentration gradient of vacancy drifts among the boundaries. As a result, a diffusional creep is produced and a part of energy is dissipated. For vacancy drift, it is required that the thermal jogs emit (absorb) vacancies, which brings climbing bow of segments into operation, and another part of energy is dissipated so that there are two parts of energy dissipated in the strain process connected with polygonization boundary. Based on this point of view, the mathematical expressions of internal friction and modulus defect associated with polygonization boundary were subsequently derived and found to be in satisfactory agreement with experiments. (author). 13 refs, 6 figs.

42071 (IC–90/32) **Fermi hyper-netted chain theory on a lattice: The Hubbard model.** Wang, X.Q. (International School of Advanced Studies, Trieste (Italy)); Wang, X.Q.G.; Fantoni, S.; Tosatti, E.; Yu Lu. International Centre for Theoretical Physics, Trieste (Italy). Feb 1990. 25p. Order Number DE90631769. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

We review a new lattice version of Fermi Hyper-Netted Chain method for the study of strongly interacting electrons. The ordinary paramagnetic and the spin density wave functions have been correlated with Jastrow-type and e-d correlations, and the corresponding FHNC equations for the pair distribution function, the one body density matrix and the staggered magnetization are discussed. Results for the 1D chain and 2D square lattice models are presented and compared with the available results obtained within Quantum Monte Carlo, variational Monte Carlo and exact diagonalization of a 4x4 Hubbard cluster. Particularly interesting are the strong effects of e-d correlations on E/Nt and on the momentum distribution as well as antiferromagnetic behavior away from half filling found in our FHNC calculations in agreement with other studies. (author). 35 refs, 8 figs, 2 tabs.

42072 (IC–90/55) **Brownian motion of spins; generalized spin Langevin equation.** Jayannavar, A.M. International Centre for Theoretical Physics, Trieste (Italy). Mar 1990. 8p. Order Number DE90631764. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

We derive the Langevin equations for a spin interacting with a heat bath, starting from a fully dynamical treatment. The obtained equations are non-Markovian with multiplicative fluctuations and concomitant dissipative terms obeying the fluctuation-dissipation theorem. In the Markovian limit our equations reduce to the phenomenological equations proposed by Kubo and Hashitsume. The perturbative treatment on our equations lead to Landau-Lifshitz

equations and to other known results in the literature. (author). 16 refs.

42073 (IC–90/56) **Statistical fluctuations in random trapping models.** Jayannavar, A.M. International Centre for Theoretical Physics, Trieste (Italy). Mar 1990. 6p. Order Number DE90631765. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

Through a very simple treatment we have constructed a lower bound for the statistical fluctuations of total survival probability of particles moving diffusively in a medium with random traps. We show that the asymptotic behaviour of the total survival probability is a non self-averaging quantity in that the fluctuations dominate the mean value. (author). 29 refs.

42074 (ITEF–86-89) **Complex of GRAD programs for analytical calculation of radiation defects generation in solids.** Suvorov, A.L.; Zabolotnyj, V.T.; Babaev, V.P. Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow (USSR). Inst. Teoreticheskoj i Ehksperimental'noj Fiziki. 1989. 16p. (In Russian). Order Number DE90631893. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Complex of programms for analytical calculation of generation of radiation defects (GRAD) in solids, and also of their recombination during cascade area relaxation and postradiation annealing, of mass removing by atomic collisions in volume (mixing) and through the surface (sputtering), of structure - phase state and property changes is suggested. The complex volume is less than 10 KBytes and it may be realized by computer of any type. Satisfactional agreement with more wide range of experimental data in comparison with tradition models is obtained. 27 refs.; 2 figs.

42075 (IYaF–88-149) **Ultraviolet radiation emission during microsecond relativistic electron beam interaction with a foil placed into a magnetic mirror.** Syresin, E.M. AN SSSR, Novosibirsk (USSR). Inst. Yadernoj Fiziki. 1988. 14p. (In Russian). Order Number DE90631894. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The results of calculations of radiation - generation by electron beams of microsecond duration with power density of 10.5 GW/cm^2 and energy storage in the beam $Q_0 \simeq 100 \simeq 150$KJ are given. The efficiency of transformation of beam energy in radiation despite a rather high power density can be quite significant and achieve 30%. It is proved that on the basis of existing accelerators the development of UV sources with energy storage 25-30 kJ and λ=50-100nm is possible.

42076 (JINR-E–2-89-233) **Investigation of aluminium, titanium and iron structural materials activation by 1.0-1.3 GeV protons.** Barashenkov, V.S. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Computing Techniques and Automation); Volchanskij, A.V.; Kondrat'ev, L.N. Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Computing Techniques and Automation. 1989. 12p. Order Number DE90631895. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Submitted to Nucl. Instrum. Methods.

Data on induced γ-radioactivity which was measured and calculated using cascade-evaporation model in Al,Ti and Fe targets irradiated by protons with energies 1.0-1.3 GeV are compared. Yield of radionuclides is determined. Depth distribution of radionuclides produced in aluminium and iron targets is discussed. The discrepancy between experimental and theoretical data is about 20-30% on the average. 14 refs.; 3 figs.; 2 tabs.

42077 (JINR-E–14-89-336) **On the fractal nature of carbonate and apatite rocks.** Bezzabotnov, V.Yu. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Neutron Physics); Gordelij, V.I.; Ostanevich, Yu.M.; Kornyshev, A.A.; Kostin, A.K. Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Neutron Physics. 1989. 8p. Order Number DE90631774. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

Small angle neutron scattering experiments were performed to investigate the porous structure of the basic components of the apatite-carbonate ores. It is shown that the surfaces of carbonate mineral grains taken from various sorts of ores are the Euclidean fractals with fractal dimensions 2<D <or approx. 2.25. Preliminary results for apatites show their more developed fractal porosity. 19 refs.; 4 figs.; 1 tab.

42078 (KEK–89-19, pp. 19-29) **Crystal field excitations in $CeSi_x$.** Kohgi, M. (Tohoku Univ., Sendai (Japan). Dept. of Physics); Satoh, T.; Ohoyama, K.; Arai, M.; Osborn, R. National Lab. for High Energy Physics, Tsukuba, Ibaraki (Japan). Dec 1989. (CONF-8911202–: 2. workshop of Japan-UK collaboration on neutron scattering research, Tsukuba (Japan), 1 Nov 1989). In *Proceedings of the second workshop of Japan-UK collaboration on neutron scattering research.* Order Number DE90798861. Available from NTIS (US Sales Only), PC A07/MF A01.

We performed the neutron inelastic scattering experiments on the $CeSi_x$ system (x=1.7, 1.8 and 1.9) in order to study the composition dependence of the crystal field excitations. The reference material $CeGe_{1.7}$ was also measured. We found that the linewidths of the excitations in $CeSi_x$ are anomalously large even in the ferromagnetic compounds and increase with increasing x. The linewidth increase is remarkable in the heavy electron regions. (author).

42079 (KU-HCOE-FL2-R–90-1) **Localization and interaction effects in GaAs/AlGaAs heterostructures modified by ^{4}He-ion implantation.** Taboryski, R.; Veje, E.; Lindelof, P.E. Copenhagen Univ. (Denmark). H.C. Oersted Inst. 1990. 14p. Contract SNF 11-4011;FTU 5.17.1.1.09. Order Number DE90631896. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Magnetoresistance is used to study localization and interaction in the 2-dimensional electron layer of ^{4}He-ion implanted GaAs/AlGaAs modulation doped heterostructures. At very low magnetic fields weak localization magnetoresistance can be fitted to theory, thereby determining the diffusion constant and the phase relaxation rate. An unexpected saturation of the phase relaxation rate at low temperature was found to have an interesting relation to mobility and sample size. In the magnetic field range, where the cyclotron radius becomes of the order of the mean free path, the magnetoresistance was related to the effect of electron-electron interaction. By comparison of the magnetoresistance at different implantation doses, we extracted a remnant quantum correction to the conductivity, which has no earlier been noticed. In samples with two subbands populated interband scattering is observed to cause spin-orbit effects in the weak localization magnetoresistance. (orig.).

42080 (KU-HCOE-FL2-R–90-2) **Bombardment-induced modification of GaAs/AlGaAs heterostructures.** Taboryski, R.; Lindelof, P.E.; Veje, E. Copenhagen Univ. (Denmark). H.C. Oersted Inst. 1990. 15p. Contract SNF 11-4011;FTU 5.17.1.1.09. (CONF-890821–: 13. international conference on atomic collisions in solids, Aarhus (Denmark), 7-11 Aug 1989). Order Number DE90631897. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

We have irradiated some GaAs/AlGaAs heterostructures with 80 keV He^+ ions and studied bombardment-induced changes of the electrical resistivity and the carrier density of a two-dimensional electron layer located at the intersection between a GaAs buffer and an AlGaAs spacer. The whole structure was so thin that the projectiles passed through the two-dimensional electron layer and stopped in the supporting substrate. The resistivity and the carrier density of the samples were determined at temperatures between 1.2 K and 4.2 K before and after the bombardments, which were carried out at room temperature. The carrier density was determined from Shubnikov-de Haas oscillations. An interesting result is that the resistivity depends strongly on the projectile fluence in contrast to the carrier density. As an example, a fluence of $3x10^9$ He^+ ions per cm^2 doubles the resistance but reduces the carrier density by 5% only. (orig.).

42081 (KU-HCOE-FL2-R–90-3) **Quantum corrections to conductivity observed at intermediate magnetic fields in a high mobility GaAs/AlGaAs 2-dimensional electron gas.** Taboryski, R.; Veje, E.; Lindelof, P.E. Copenhagen Univ. (Denmark). H.C. Oersted Inst. 1990. 15p. Contract SNF 11-4011;FTU 5.17.1.1.09. Order Number DE90631775. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Magnetoresistance with the field perpendicular to the 2-dimensional electron gas in a high mobility GaAs/AlGaAs heterostructure at low temperatures is studied. At the lowest magnetic

field we observe the weak localization. At magnetic fields, where the product of the mobility and the magnetic field is of the order of unity, the quantum correction to conductivity due to the electron-electron interaction is as a source of magnetoresistance. A consistent analysis of experiments in this regime is for the first time performed. In addition to the well known electron-electron term with the expected temperature dependence, we find a new type of temperature independent quantum correction, which varies logarithmically with mobility. (orig.).

42082 (KU-HCOE-FL2-R–90-4) **Weak localization and electron-electron interaction in modulation doped GaAs/AlGaAs heterostructures.** Taboryski, R.; Lindelof, P.E. Copenhagen Univ. (Denmark). H.C. Oersted Inst. 1990. 50p. Contract FTU 5.17.1.1.09;SNF 11-4011. Order Number DE90631898. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The first heterostructure wafer only had one electronic subband at the GaAs/AlGaAs interface populated. Weak localization magnetoresistance was interpreted by a theory valid to relatively high magnetic fields and also valid for electrons with a long mean free path. The adjustable parameter in fitting the magnetoresistance was in each case the phasebreaking relaxation time, which could then subsequently be plotted as a function of temperature. The temperature dependence of the phasebreaking rate could be interpreted on the basic of existing theories, but the residual relaxation rate at the lowest temperature remains so far unexplained. Already at low magnetic fields the weak localization magnetoresistance saturates, indicating a complete quench of weak localization. We find that the value of saturation (i.e. the total weak localization at the appropriate temperature) was smaller than predicted by the existing theories. At magnetic fields of the order of the inverse electron mobility, a quadratic magnetoresistance show up in our experiments. This quadratic magnetoresistance corresponds to corrections to the conductivity of the order of e^2/h. Whereas we find that the temperature dependence of this conductivity correction is well in agreement with predicted effects of electron-electron interaction, the dependence on mobility, which we can measure via our ion implantation, is larger than any existing theory predicts, yet still in the ballpark of the conductance quantum. (orig./BHO).

42083 (KU-HCOE-FL2-R–90-5) **Quantum Hall samples prepared by helium-ion implantation.** Bruus, H. (Danish Inst. of Fundamental Metrology, Lyngby (Denmark)); Lindelof, P.E.; Veje, E. Copenhagen Univ. (Denmark). H.C. Oersted Inst. 1990. 3p. Order Number DE90631899. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

We have produced GaAs/GaAlAs heterostructure based quantum Hall samples with a wide range of electron mobilities using ion implantation. The purpose has been to optimize the samples for use in metrology. We have in particular studied the critical current and the non-ohmic behavior of our samples in the vicinity of a quantum Hall plateau. (orig.).

42084 (LBL–28526) **Nonlinear optical studies of molecular adsorbates.** Shen, Y.R. (California Univ., Berkeley, CA (USA). Dept. of Physics). Lawrence Berkeley Lab., CA (USA). Mar 1990. 6p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00098. (CONF-9001103–1: 4. US/USSR bilateral symposium on the physics of optical phenomena, Irvine, CA (USA), 23-27 Jan 1990). Order Number DE90013359. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

In recent years, the possibility of employing laser interaction with surfaces as a surface diagnostic tool has attracted a great deal of attention. Optical second harmonic generation (SHG) and sum-frequency generation (SFG) have been proven to be most effective and versatile for surface and interfacial studies. By symmetry, these processes are forbidden in media with centrosymmetry, and can therefore be highly surface-specific. They have the advantages of being capable of high spatial temporal and spectral resolutions, suitable for in-situ, remote sensing of samples in hostile environment and applicable to all interfaces accessible to light. Indeed, they have been applied with great success to a large variety of surface and interfacial problems: probing adsorption and desorption of molecules from surfaces, measuring average molecular orientation of adsorbates, monitoring surface symmetry and surface phase transitions, conducting surface microscopy and spectroscopy, and many others. Here, we shall describe a few experiments recently carried out in our laboratory using these techniques.

42085 (PB–90-868845/XAB) **Nuclear magnetic resonance coils. January 1975-March 1990 (A Bibliography from the INSPEC: Information Services for the Physics and Engineering Communities data base). Report for January 1975-March 1990.** National Technical Information Service, Springfield, VA (USA). May 1990. 80p. Available from NTISPC N01/MF N01.

Supersedes PB–89-851711.

This bibliography contains citations concerning the coils used to produce images in Nuclear Magnetic Resonance (NMR) imaging. Placement of NMR probes and coils in resonance devices is described. Probe construction, tuning, and spinning are discussed, and methods of reducing ringing in NMR probes are explored. Probe and coil design for high pressure, high temperature, cryogenic, and variable temperature applications are considered. (This updated bibliography contains 139 citations, 17 of which are new entries to the previous edition.)

42086 (RISO-M–2846) **X-ray reflectivity of a 200 layer $W_{.25}Si_{.75}$ multilayer crystal.** Als-Nielsen, J. (Risoe National Lab., Roskilde (Denmark). Physics Dept.); Grey, F. Risoe National Lab., Roskilde (Denmark). Jan 1990. 21p. Order Number DE90631776. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

X-ray reflectivity studies of a synthetic 200 layer $W_{25}Si_{75}$ crystal on a Si wafer with a d-spacing of 25 A yielded the following results: At a fixed wavelength of 1.54 A the reflectivity for grazing incidence below a critical angle of 5.1 mrad exceeds 70%. The peak reflectivity of the first order Bragg reflection at the Bragg angle of 31 mrad is 78% of the totally reflected beam, and the relative band width of the peak is 2.1%. Both these numbers are in good agreement with the simplest form of dynamical scattering theory as outlined in the text. The reflectivity of higher harmonics is less than a few per cent, with the fundamental set for reflection at 1.54 A. Crystals of this quality are very useful optical elements in synchrotron radiation instrumentation, in particular when adequate cooling methods are fully developed. (orig.) With 4 figs., 4 refs.

42087 **Lateral confinement in quantum nanostructures: Self-consistent screening potentials.** Luscombe, J.H. (Central Research Laboratories, Texas Instruments, Inc., Dallas, Texas 75265 (USA)); Luban, M. *Applied Physics Letters (USA)*, 57(1): 61-63 (2 Jul 1990). DOE Contract W-7405-ENG-82.

Self-consistent lateral confining potentials and carrier density functions are computed for quantum nanostructures utilizing a finite-temperature Thomas–Fermi approximation for the conduction electrons and the assumption of a uniform background of donor charges. The formation of the confining potential is the result of a nonlinear, electrostatic screening process which is determined by the Fermi level pinning properties of the lateral surfaces, the doping level, and the lateral dimensions. We find that the ability to populate nanostructures with carriers depends sensitively upon the details of the system.

42088 **Experimental investigation of radiation from the interaction of an electron beam and a conducting grating.** Shih, I. (Hughes Aircraft Company, Support Systems, P.O. Box 9399, Long Beach, CA (USA)); Chang, D.B.; Drummond, J.E.; Dubbs, K.L.; Masters, D.L.; Prohaska, R.M.; Salisbury, W. *Optics Letters (USA)*, 15(10): 559-561 (15 May 1990). DOE Contract FG03-85ER13448.

Recent experimental results on the radiation generated from an electron beam passing closely over a conducting grating are presented. The most striking results are that the output power is 4 orders of magnitude more intense than that predicted by the Smith–Purcell explanation and that the output power increases exponentially with the beam thickness until it saturates at a thickness of a 1000 times the grating period. The recent theoretical model of Chang and McDaniel [Phys. Rev. Lett. **63**, 1066 (1989); J. Opt. Soc. Am. B **7**, 239 (1990)] is shown to compare favorably with these results.

42089 **Phonon propagation with isotope scattering and spontaneous anharmonic decay.** Maris, H.J. (Department of

Physics, Brown University, Providence, RI (USA)). *Physical Review, B: Condensed Matter (USA)*, 41(14): 9736-9743 (15 May 1990). DOE Contract FG02-88ER40452 ;FG02-86ER45267.

Calculations of the propagation of high-energy phonons introduced into a crystal at T=0 K are presented. The phonons are assumed to undergo elastic scattering and anharmonic decay processes. We show that in addition to the "quasidiffusion" component to the phonon propagation (discussed previously by Levinson and co-workers) there is also a contribution that arrives at close to the time expected for ballistic propagation. This latter mode of propagation continues to be of substantial importance even when the elastic scattering is much stronger than the anharmonic processes.

42090 Harris functional and related methods for calculating total energies in density-functional theory. Averill, F.W. (Metals and Ceramics Division, Oak Ridge National Laboratory, Oak Ridge, TN (USA)); Painter, G.S. *Physical Review, B: Condensed Matter (USA)*, 41(15): 10344-10353 (15 May 1990). DOE Contract AC05-84OR21400.

The simplified energy functional of Harris has given results of useful accuracy for systems well outside the limits of weakly interacting fragments for which the method was originally proposed. In the present study, we discuss the source of the frequent good agreement of the Harris energy with full Kohn-Sham self-consistent results. A procedure is described for extending the applicability of the scheme to more strongly interacting systems by going beyond the frozen-atom fragment approximation. A gradient-force expression is derived, based on the Harris functional, which accounts for errors in the fragment charge representation. Results are presented for some diatomic molecules, illustrating the points of this study.

42091 Ballistic transport in a novel one-dimensional superlattice. Ulloa, S.E. (Department of Physics and Astronomy, Ohio University, Athens, OH (USA)); Castano, E.; Kirczenow, G. *Physical Review, B: Condensed Matter (USA)*, 41(17): 12350-12353 (15 Jun 1990). DOE Contract FG02-87ER45334.

We point out that fabrication and experimental study of a one-dimensional semiconductor superlattice (1DSL) structured in a ballistic constriction is now feasible and present a theory of its transport properties. We predict sharp switching between quantized conductance plateaus as the Fermi level moves through the 1DSL miniband gaps and strong resonant conductance oscillations. Surprisingly, these effects are predicted to be observable even for 1DSL's with very few periods and to be nearly independent of the geometry of the constriction openings.

42092 Chiral Luttinger liquid and the edge excitations in the fractional quantum Hall states. Wen, X.G. (School of Natural Sciences, Institute for Advanced Study, Princeton, New Jersey 08540 (USA)). *Physical Review, B: Condensed Matter (USA)*, 41(18): 12838-12844 (15 Jun 1990). DOE Contract AC02-76ER02220.

The low-energy effective theory of the edge excitations in the fractional quantum Hall (FQH) states is derived. The edge excitations are shown to form a new kind of state which is called the chiral Luttinger liquid (χLL). The effective theory is exactly soluble. This enables us to easily calculate all the low-energy properties of the edge excitations. We calculate the electron propagator and the spectral function, which clearly demonstrate the non-Fermi-liquid behaviors of the χLL. We also calculate the interference effects between excitations on different edges. We demonstrate that the properties of the edge excitations are closely related to the properties of the FQH states on compacted spaces. Thus the properties of the edge excitations can be used to characterize the topological orders in the FQH states. We also show that the FQH states with filling fractions $\nu=p/(2mp\pm1)$ must have at least two branches of edge excitations.

6561 Superconductivity

Refer also to citation(s) 41000, 41032, 41034, 41035, 41038, 41043, 41047, 41049, 41054, 41055, 41056, 41435, 41438

42093 (DOE/ER/45347–T2) **Strongly interacting fermion systems: Progress report, [November 15, 1989–November 14, 1990].** Wilkins, J.W. Ohio State Univ. Research Foundation, Columbus, OH (USA). [1990]. 7p. Sponsored by U.S. DOE Energy Research. DOE Contract FG02-88ER45347. Order Number DE90014430. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

Research has been concentrated primarily in three areas: heavy fermions, physics of high-temperature superconductivity, and electronic properties. In heavy fermions a peak in the attenuation coefficient of ultrasound just below the superconducting transition temperature can be explained in the context of conventional (BCS) superconductivity theory by recognizing how profoundly that theory is reorganized in heavy fermion systems in which the sound velocity. In high-temperature superconductors there have been development of a model for magnetism in one alloy which shows unusual first-order phase transitions in a magnetic field, a possible mechanism for high-temperature superconductivity based on an electric quadrupole moment of Cu in tetragonal crystal geometry, and a neat resolution of a paradox between a theory connecting gaps in spectrum with the degeneracy of the system and a prominent current theoretical view that there is a gap and no degeneracy. It turns out there is topological degeneracy that had been previously recognized. In electronic structure we have shown that the finite element approach can be used for electronic systems with an efficient code using more than a half-million local basis functions. In addition, we have developed a variational principle for determining optimal meshes for solving differential equations–such as the Schroedinger equation.

42094 (IC–90/49) **On the localisation of charge carriers and suppression of superconductivity by praseodymium in systems derived from $YBa_2Cu_3O_{7-d}$.** Infante, C.; El Mously, M.K.; Dayal, R.; Husain, M.; Siddiqi, S.A.; Ganguly, P. International Centre for Theoretical Physics, Trieste (Italy). Apr 1990. 34p. Order Number DE90632141. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The effect of Pr substitution in suppressing T_c in $LaCaBaCu_3O_{7-d}$ and $Y_{0.8}Ca_{0.2}Ba_2Cu_3O_{6+d}$ has been studied. Infra-red spectroscopy and a model based on ionic radii considerations were used to examine the location of Pr ions and the influence of Pr and Ca ions on hole localisation on chains and planes. For this purpose the series $PrBa_{2-x}Ca_xCu_3O_{7-d}$ was also studied. The main conclusions are that Pr ions play a role in suppressing T_c by exchange scattering and to some extent by the hole filling mechanism involving the formation of Pr^{4+}. The Pr ions in $La_{1-x}Pr_xCaBaCu_3O_{7-d}$ exist in both the Y and Ba sites. The magnitude of the resistivity at the insulator-metal transition for the polycrystalline samples is consistent with an anisotropic superconductor in which superconductivity accompanies metallization. The rate of suppression of T_c is similar as in $Y_{1-x}Pr_xBa_2Cu_3O_{7d}$ but it is suggested that a percolation model may explain the results more adequately than the Abrikosov-Gorkov theory. (author). 48 refs, 10 figs, 1 tab.

42095 (IC–90/65) **Multiple exchange interaction and high-T_c superconductivity.** Liu Fusui (International Centre for Theoretical Physics, Trieste (Italy)); Chen Wanfang. International Centre for Theoretical Physics, Trieste (Italy). Mar 1990. 14p. Order Number DE90632142. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

It has been shown that in a strongly correlated system there is multiple exchange interaction, the detailed derivation of which will be given here. From the numerical calculations of T_c,T_c vs. x and y for $La_{2-x}Sr_xCuO_4$ and $Y_1Ba_2Cu_3O_{7-y}$, the small isotope effect, and some explanations for the observed phenomena, this paper once again affirms that high-T_c SC (superconductivity) is almost completely caused by the multiple exchange interaction and layer tunnelling coupling. This paper also concludes that the Cooper pair consists of Opσ holes in CuO_2. (author). 20 refs, 4 figs.

42096 (JINR-E–14-89-455) **μSR-investigation of high-T_c superconductors at the LNP JINR phasotron.** Bezhitadze, D.T. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow (USSR). Inst. Atomnoj Ehnergii); Borovinskaya, I.P.; Burianek, J. Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems. 1989. 8p. Order Number DE90632143. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

High-T_c superconductors $La_{2-x}Sr_xCuO_4$ (x=0+0.25), Ho(Er)$Ba_2Cu_3O_{7-y}$ and Bi-Sr-Ca-Cu-O (the main phase 2212 with

a small admixture of the 2223-phase) were investigated in the zero and 100÷400 Oe transverse external magnetic fields in the temperature interval 4.2÷300 K. The magnetic ordering for the $La_{2-x}Sr_xCuO_4$ samples with x=0.00 and x=0.01 occurs below $T_N \propto 250$ K and $T_N \propto 170$ K respectively. A considerable increase in the distribution width of the magnetic field on the muon with an increase in the Sr-content indicates an enhancement of the Cu^{2+} magnetic moment deviation from the magnetic ordering axis. The results of the analysis of the μSR spectra indicate the formation of the spin glass state in the $La_{1.93}Sr_{0.07}CuO_4$ sample. In contrast to the behaviour of the $HoBa_2Cu_3O_{7-y}$ ceramic the magnetic ordering of the Er-atoms in the $ErBa_2Cu_3O_{7-y}$ sample is not observed in the conparable temperature interval. Our data has also allowed the magnetic field penetration depth $\lambda_{perpendicular}(0)$ to be determined: 3200±70 A for $La_{1.9}Sr_{0.1}CuO_4$, 2420±60 A for $La_{1.85}Sr_{0.15}CuO_4$, 2000±50 A for Bi-Sr-Ca-Cu-O (phase 2212), 1600±50 A for $ErBa_2Cu_3O_{7-y}$. 20 refs.; 8 figs.

42097 (JINR-R–14-89-147) **Neutron diffraction study of Fe-substituted $YBa_2Cu_3O_7$.** Balagurov, A.M. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Neutron Physics); Mironova, G.M.; Pajaczkowska, A.; Piechota, J.; Shimchak, Kh. Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Neutron Physics. 1989. 8p. (In Russian). Order Number DE90632144. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

Neutron diffraction spectra of $YBa_2(Cu_{1-x}Fe_x)O_{7-\delta}$($0<x\leq0.12$ and $\delta=0$) samples were obtained and refined by the Rietveld technique. The occupancies of Cu1 and Cu2 sites were estimated and the probabilities of substitution of Cu by Fe in Cu-O chains and CuO_2 planes were determined. It is significant that the doped iron atoms occupy both of the copper site. The substitution of Fe for Cu in (2q) site is proportional to the concentration of iron in the sample. For small x there are a considerable amount of vacancies (10%) in the Cu1 site, which disappear quickly if x increases. Therefore, a joint effect of Cu substitution and the filling in vacancies by Fe occures for the Cu1 site. The amount of oxygen in samples increases with x up to 7.06 for x=0.12. Any visible effect of location of Fe at the Ba site is absent, but we can not exclude it completely. 20 refs.; 4 figs.; 1 tab.

42098 (PB–90-870585/XAB) **Meissner effect in superconductors. January 1977-October 1987 (A Bibliography from the INSPEC: Information Services for the Physics and Engineering Communities data base). Report for January 1977-October 1987.** National Technical Information Service, Springfield, VA (USA). Jun 1990. 86p. Available from NTISPC N01/MF N01.

See also PB–90-870593.

This bibliography contains citations concerning studies of Meissner effect in superconducting materials and devices. Topics include Meissner flux expulsion, Meissner effect measurements, Meissner effect of high temperature superconductors, Meissner effect under various pressures, shielding effect of Meissner currents, superconducting transition temperature, and Josephson junctions. Meissner effect studies of Y-Ba-Cu-O systems, La-Sr-Cu-O systems, magnetic superconductors, organic superconductors, superconducting magnets, and superconducting films are examined. (This updated bibliography contains 166 citations, none of which are new entries to the previous edition.)

42099 (PB–90-870593/XAB) **Meissner effect in superconductors. November 1987-May 1990 (A Bibliography from the INSPEC: Information Services for the Physics and Engineering Communities data base). Report for November 1987-May 1990.** National Technical Information Service, Springfield, VA (USA). Jun 1990. 192p. Available from NTISPC N01/MF N01.

Supersedes PB–88-851969. See also PB–90-870585.

This bibliography contains citations concerning studies of Meissner effect in superconducting materials and devices. Topics include Meissner flux expulsion, Meissner effect measurements, Meissner effect of high temperature superconductors, Meissner effect under various pressures, shielding effect of Meissner currents, superconducting transition temperature, and Josephson junctions. Meissner effect studies of Y-Ba-Cu-O systems, La-Sr-Cu-O systems, magnetic superconductors, organic superconductors, superconducting magnets, and superconducting films are examined. (This updated bibliography contains 330 citations, all of which are new entries to the previous edition.)

42100 (SAND–90-1573C) **Stoichiometry and irradiation effects in melt grown Tl-Ca-Ba-Cu-O single crystals.** Venturini, E.L.; Tigges, C.P.; Baughman, R.J.; Morosin, B.; Barbour, J.C.; Mitchell, M.A.; Ginley, D.S. Sandia National Labs., Albuquerque, NM (USA). [1990]. 12p. Sponsored by U.S. DOE Energy Research. DOE Contract AC04-76DP00789. (CONF-900738–2: 8. American conference on crystal growth, Vail, CO (USA), 15-20 Jul 1990). Order Number DE90013365. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Melt-grown crystals in the Tl-Ca-Ba-Cu-O system with the same structure type can have substantial differences in the superconducting transition, both in width and onset temperature. These differences are attributed to stoichiometry variations arising from cation site substitution. Magnetization and electrical resistivity data are presented which emphasize the extreme sensitivity of the superconductivity to the exact stoichiometry in this system. High quality single crystals exhibit large flux creep due to a weak pinning potential for magnetic flux lines. Flux pinning and thus the critical current density are shown to be significantly enhanced by irradiation with high-energy protons or neutrons. 25 refs., 3 figs., 1 tab.

42101 Formation of high-T(c) superconducting films by organometallic chemical vapor deposition. Berry, A.; Gaskill, D.; Holm, R.; Cukauskas, E. To Department of the Navy, Washington, DC (US). USA Patent Application 7-352,325. 16 May 1989. 25p. Available from NTISPC N03/MF A01.

This Government-owned invention available for U.S. licensing and, possibly, for foreign licensing. Copy of application available NTIS.

This invention relates to a method of forming high Tc superconducting films by organometallic chemical vapor deposition. More specifically, this invention relates to a method of forming superconducting films on a semiconductor surface by chemical vapor deposition of volatile organometallic compounds of the rare earth and alkaline earth elements, and copper.

6570 Theoretical and Mathematical Physics

Refer also to citation(s) 41278, 41494, 41953, 41968, 42050

42102 (ANL-HEP-CP–90-32) **Consistent multiparameter quantisation of GL(n).** Sudbery, A. (York Univ. (UK). Dept. of Mathematics). Argonne National Lab., IL (USA). Apr 1990. 10p. Sponsored by U.S. DOE Energy Research. DOE Contract W-31109-ENG-38. (CONF-9004228–1: Informal spring workshop on quantum groups, Argonne, IL (USA), 26 Apr - 11 may 1990). Order Number DE90013689. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

We describe a manifold of quantum group structures on the vector space of the universal enveloping algebra of gl(n) and on its dual, the space of polynomials in n^2 variables. The dimension of the manifolds is $(n^2 - n + 2)/2$. 7 refs.

42103 (IC–89/275) **Differential operators associated with Hermite polynomials.** Onyango Otieno, V.P. International Centre for Theoretical Physics, Trieste (Italy). Sep 1989. 15p. Order Number DE90631579. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

This paper considers the boundary value problems for the Hermite differential equation $-(e^{-x2}y'(x))'+e^{-x2}y(x)=\lambda e^{-x2}y(x)$, (x is an element of $(-\infty, \infty)$) in both the so-called right-definite and left-definite cases based partly on a classical approach due to E.C. Titchmarsh. We then link the Titchmarsh approach with operator theoretic results in the spaces $L_w^2(-\infty, \infty)$ and $H_{p,q}^2(-\infty, \infty)$. The results in the left-definite case provide an indirect proof of the completeness of the Hermite polynomials in $L_w^2(-\infty, \infty)$. (author). 17 refs.

42104 (IC–89/276) **On some properties of the Laguerre-type differential operators.** Onyango Otieno, V.P. International Centre for Theoretical Physics, Trieste (Italy). Sep 1989. 21p. Order Number DE90631580. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The 4th-order Laguerre-type differential equation and its non-classical orthogonal polynomial solutions were discovered by H.L. Krall in 1938. The associated right-definite boundary value problem was later studied by A.M. Krall in 1981. This paper considers this right-definite problem from a different point of view which enables us to study the 4th-order equation and the polynomials in the left-definite case. As a consequence, orthogonality of the derivatives of the Laguerre-type polynomials is obtained. The methods are motivated by the recent work of Everitt and Littlejohn on Legendre-type polynomials; and extend the earlier work of Titchmarsh and Otieno on the right-definite and left-definite problems associated with the classical Laguerre polynomials. (author). 19 refs.

42105 (IC–89/347) **Thermodynamics of squeezed states for the Kanai-Caldirola Hamiltonian.** Aliaga, J. (Comision Nacional de Investigaciones Espaciales, Vicente Lopez (Argentina). Lab. de Fisica); Crespo, G.; Proto, A.N. International Centre for Theoretical Physics, Trieste (Italy). Dec 1989. 41p. Order Number DE90631590. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Using the maximum entropy approach, we analyze the appearance of coherent and squeezed states for the Kanai-Caldirola Hamiltonian, it being possible to extend the analysis easily to the so-called Generalized Harmonic Oscillator and a kind of two-photon Hamiltonian, for both the zero and non-zero temperature cases. A connection between the possibility of obtaining squeezing and the relevant operators included in the density matrix is shown. Finally, a comparison with pertinent previous results in the literature is also presented. (author). 19 refs, 2 figs.

42106 (IC–89/386) **Bimetric gravity: BRST-invariance and space-time diffeomorphisms.** Soloviev, V.O. International Centre for Theoretical Physics, Trieste (Italy). Dec 1989. 10p. Order Number DE90631619. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

From the work by Isham and Kuchar it is well known that in General Relativity space-time diffeomorphism algebra cannot be realized canonically without an additional structure. Here we show that the background Minkowski metric together with the covariant De Donder-Fock condition can serve as such a structure. For this purpose we use the BRST-invariant formalism of Relativistic Theory of Gravitation. (author). 16 refs.

42107 (IC–90/12) **The computer algebra approach of the finite difference methods for PDEs.** Liu Ruxun. International Centre for Theoretical Physics, Trieste (Italy). Jan 1990. 21p. Order Number DE90631581. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

In this paper, a first attempt has been made to realize the computer algebra construction of the finite difference methods or the finite difference schemes for constant coefficient partial differential equations. (author). 9 refs, 2 tabs.

42108 (IC–90/25) **Monogenic functions with parameters in Clifford analysis.** Le Hung Son. International Centre for Theoretical Physics, Trieste (Italy). Feb 1990. 14p. Order Number DE90631582. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

In this paper we study some properties of monogenic functions taking values in a Clifford algebra and depending on several parameters. It is proved that the Hartogs extension theorems are valid for these functions and for the multi-monogenic functions, which contain solutions of many important systems of partial differential equations in Theoretical Physics. (author). 4 refs.

42109 (IC–90/26) **Null geodesics in black hole metrics with non-zero cosmological constant.** Stuchlik, Z. (International Centre for Theoretical Physics, Trieste (Italy)); Calvani, M. International Centre for Theoretical Physics, Trieste (Italy). Feb 1990. 24p. Order Number DE90631620. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

We study the radial motion along null geodesics in the Reissner-Nordstroem-de Sitter and Kerr-de Sitter space-times. We analyze the properties of the effective potential and we discuss circular orbits. We find that the radii of circular geodesics in the Reissner-Nordstroem-de Sitter space-time do not depend on the cosmological constant, and we explain this property using the optical reference geometry. In addition, we describe the unusual consequences of the interplay between rotation of the source and cosmological repulsion. (author). 16 refs, 8 figs.

42110 (IC–90/29) **A necessary and sufficient condition for a real quadratic extension to have class number one.** Alemu, Y. International Centre for Theoretical Physics, Trieste (Italy). Feb 1990. 19p. Order Number DE90631583. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

We give a necessary and sufficient condition for a real quadratic extension to have class number one and discuss the applicability of the result to find the class number one fields with small discriminant. 9 refs, 3 tabs.

42111 (IC–90/37) **Complete metrics with nonpositive curvature on the disk.** Duong Minh Duc. International Centre for Theoretical Physics, Trieste (Italy). Feb 1990. 9p. Order Number DE90631584. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

We consider complete metrics on the unit disk in R^2 which are equivalent and conformal to the Poincare metric. (author). 9 refs.

42112 (IC–90/61) **Gravity induced corrections to quantum mechanical wave functions.** Singh, T.P. International Centre for Theoretical Physics, Trieste (Italy). Mar 1990. 9p. Order Number DE90631591. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

We perform a semiclassical expansion in the Wheeler-DeWitt equation, in powers of the gravitational constant. We then show that quantum gravitational fluctuations can provide a correction to the wave-functions which are solutions of the Schroedinger equation for matter. This also implies a correction to the expectation values of quantum mechanical observables. (author). 6 refs.

42113 (IC–90/64) **A comparison theorem of the Kobayashi metric and the Bergman metric on a class of Reinhardt domains.** Weiping Yin. International Centre for Theoretical Physics, Trieste (Italy). Mar 1990. 10p. Order Number DE90631585. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

A comparison theorem for the Kobayashi and Bergman metric is given on a class of Reinhardt domains in C^n. In the meantime, we obtain a class of complete invariant Kaehler metrics for these domains of the special cases. (author). 5 refs.

42114 (IC–90/66) **Isometric immersions of Kaehler manifolds.** Ferreira, M.J.; Rigoli, M.; Tribuzy, R. International Centre for Theoretical Physics, Trieste (Italy). Mar 1990. 13p. Order Number DE90631586. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The present paper is concerned with obstructions to the existence of (1,1)-geodesic isometric immersions from a Kaehler manifold in M. 11 refs.

42115 (IPNO-TH–89-12) **Coding chaotic billiards: I-Non-Compact billiards on a negative curvature manifold.** Giannoni, M.J.; Ullmo, D. Paris-11 Univ., 91 - Orsay (France). Inst. de Physique Nucleaire. Mar 1989. 91p. Order Number DE90508324. Available from NTIS (US Sales Only), PC A05/MF A01.

This paper presents a method for coding billiards. The main device is to use a proper surface of section, the bounce mapping, and foliate the reduced phase space into regions associated with a given code. The alphabet is merely the ensemble of the labels of the sides of the billiard. The procedure is applied here to non-compact polygonal billiard defined on a manifold of constant negative curvature, with all vertices at infinity. A simple grammar rule is necessary and sufficient to insure existence and uniqueness of the coding.

42116 (ITPR–90015) **Multigroup representation of the scalar nonlinear Boltzmann equation.** Kuegerl, G.; Schuerrer, F. Technische Univ., Graz (Austria). Inst. fuer Theoretische Physik und Reaktorphysik. Jan 1990. 50p. (In German). Available from the Technische Universitaet Graz, Petersgasse 16, A-8010 Graz.

The scalar nonlinear Boltzmann equation is transformed into a set of multigroup equations by discretizing the atomar velocity

range. The resulting scattering coefficients are evaluated analytically for a hard-sphere gas in the equilibrium state, as well as numerically by applying the rectangular-rule. A comparison of the results proves a fast convergence of the rectangular coefficients to the Maxwell-avaraged ones, with respect to an increase of the total group number G. The multigroup equations are solved numerically for a gas consisting of Maxwellian molecules by applying Euler's method, where the scattering coefficients are obtained by means of the rectangular-rule. This solution turns out to be unstable, even for the large values of G. We eliminate this inadequacy by renormalizing the group densities after each temporal iteration step. Then the numerical result agrees excellently with an exact solution of the Boltzmann equation describing the relaxation of Maxwellian moleculares. We investigate, in which manner a Maxwellian with tail-cut-off, as a well as δ-function, relax toward the equilibrium state. The limitations of the presented multigroup method are discussed. 14 refs., 9 figs., 7 tabs. (Author).

42117 (IYaF–89-72) **What is the rate of the Arnold diffusion.** Vecheslavov, V.V.; Chirikov, B.V. AN SSSR, Novosibirsk (USSR). Inst. Yadernoj Fiziki. 1989. 30p. (In Russian). Order Number DE90631596. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Modern representations about the Arnold diffusion-universal instability of motion in multidimensional nonlinear oscillating systems are reviewed. Special attention is paid to estimations of the diffusion rate. Two new effects of the Arnold fast diffusion in the systems with strong and weak nonlinearity are discussed. 23 refs.; 8 figs.

42118 (JINR–1-34-89, pp. 28-36) **Solitons in topologically trivial and nontrivial sectors of the Skyrme model.** Nikolaev, V.A. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics); Tkachev, O.G. Joint Inst. for Nuclear Research, Dubna (USSR). 1989. (In Russian). In *JINR rapid communications: Collection.* Order Number DE90706109. Available from NTIS (US Sales Only), PC A05/MF A01; OSTI; INIS.

Using of the new predictions of form of solitons in the Skyrme model new series of baryon and meson-like configurations are obtained. Some of the obtained configurations are classically stable objects. It is shown that proposed ansatz is the generalization of the Skyrme-Witten ansatz and k Φ one. The origin and approximate character of the last ansatz was demonstrated. 5 refs.; 3 figs.; 2 tabs.

42119 (JINR–1-34-89, pp. 42-49) **Cubic forms and quantum mechanics.** Yamaleev, R.M. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Computing Techniques and Automation). Joint Inst. for Nuclear Research, Dubna (USSR). 1989. (In Russian). In *JINR rapid communications: Collection.* Order Number DE90706109. Available from NTIS (US Sales Only), PC A05/MF A01; OSTI; INIS.

Elements of trigeometry and Dicson algebra for cubic degree are given. Construction procedure of quantum mechanics of particles moving in the space trigeometry is proposed. 10 refs.

42120 (JINR-E–2-89-74) **Dirac operators with a spherically symmetric δ-shell interaction.** Dittrich, J. (Ceskoslovenska Akademie Ved, Rez (Czechoslovakia). Ustav Jaderne Fyziky); Exner, P.; Seba, P. Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics. 1989. 30p. Order Number DE90631598. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Submitted to the journal J. Math. Phys.

We study Dirac operators with a contact interaction supported by a sphere restricting our attention to the operators which are rotationally and space-reflection symmetric. The partial-wave operators are constructed using the self-adjoint extension theory, a particular attention being paid to those among them which can be interpreted as δ-function shells of scalar and vector nature. The class of interactions for which the sphere becomes impenetrable is specified and spectral properties of the obtained Hamiltonians are discussed. 23 refs.

42121 (JINR-E–2-89-273) **Structural point objects and the classical model of spin.** Entralgo, E.E. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics); Kuryshkin, V.V. Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics. 1989. 7p. Order Number DE90631597. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

Submitted to Dokl. Akad. Nauk SSSR.

A classical description is proposed for the motion in stationary fields of a structural point object, which is a cluster of charged mass points concentrated at any instant of time in a region of space the dimensions of which are inaccessible for experimental obseravations. A new classical model of spin is given. 15 refs.

42122 (JINR-E–4-89-275) **An inverse problem for classical relativistic mechanics.** Funke, H. (Zentralinstitut fuer Kernforschung, Rossendorf (German Democratic Republic)); Ratis, Yu.L. Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics. 1989. 6p. Order Number DE90631599. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

Submitted to Inverse Probl.

The inverse problem is solved for a relativistic classical point particle trapped in a confining potential. The integral equation for the period T(E) is inverted by a Laplace-transformation technique, and we finally get the explicit formula for the potential without any approximations. 3 refs.

42123 (JINR-R–2-89-175) **Moving particle field.** Strel'tsov, V.N. Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy. 1989. 4p. (In Russian). Order Number DE90631621. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

It is shown that the electric field in front of a moving charge affects ever growing distances with increasing its velocity. The idea is suggested that this effect underlies the growth of coherent length with increasing particle energy. It is noted that the growth of formation length in fast hadron collisions is due to a similar reason. 2 refs.; 2 figs.

42124 (JINR-R–2-89-198) **Classical theory of a point spin-particle and structural point objects.** Kuryshkin, V.V. (Universitet Druzhby Narodov, Moscow (USSR)); Ehntral'go, Eh.Eh. Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics. 1989. 15p. (In Russian). Order Number DE90631601. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The physical characteristics and evolution laws of a structural point object, which is a conglomerate of mass points concenrated at any instant of time in a region of space the dimentions of which are inaccessible for the direct experimental observation, are written out in the 2nd order approximation. A new classical model of spin is given and the corresponding classical description of a point spin-particle motion in external stationary fields is proposed. 21 refs.

42125 (JINR-R–2-89-234) **Specific-features of the relativistic particle interaction.** Strel'tsov, V.N. Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy. 1989. 4p. (In Russian). Order Number DE90631622. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

It is shown that the pion field in front of a moving nucleon affects ever greater distances with the growth of its velocity. An idea is expressed that this effect lies in the base of a growing formation length with increasing particle energy. Besides, it is the reason for ever growing contribution of the interactions via vector mesons that becomes dominating at $\gamma >$or approx. $2x10^2$ (γ-Lorentz-factor). 4 refs.; 1 fig.; 1 tab.

42126 (JINR-R–4-89-287) **Illustrations from the collection Quantum mechanics in pictures.** Zakhar'ev, B.N.; Plekhanov, E.B. Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics. 1989. 18p. (In Russian). Order Number DE90631602. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Submitted to the Organizing Committee of the Intern. Conf. Few Body 12, Vancouver, Canada, July 1989.

The graphs are given which elucidate the important quantum features: 1. How variations of spectral parameters (positions of energy levels or R-matrix resonances and normalizing constants or reduced widths) affect the form of potentials. 2. Bound states embedded into the continuum spectrum. Comparison of one-channel and two-channel models. 3. Resonance tunneling through a system of identical barriers. Transfer to the limit of the infinite periodical

lattice. 4. Accumulation of errors in process of integration of differential equations in finite-difference approximation. The illustrations are accompanied by comments. 11 refs.; 15 figs.

42127 (JINR-R-5-89-159) **Supersymmetry of a one-dimensional hydrogen atom.** Sisakyan, A.N. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics); Ter-Antonyan, V.M.; Pogosyan, G.S.; Lutsenko, I.V. Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics. 1989. 6p. (In Russian). Order Number DE90631603. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

It is shown that a one-dimensional hydrogen atom possesses supersymmetry that manifests itself in the momentum representation. Explicit form of charge operators and analogs of boson and fermion sectors are found. 7 refs.

42128 (JINR-R-5-89-160) **One-dimensional hydrogen atom in a quasiclassical approximation.** Sisakyan, A.N. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics); Ter-Antonyan, V.M.; Pogosyan, G.S.; Lutsenko, I.V. Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics. 1989. 11p. (In Russian). Order Number DE90631604. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Submitted to J. Phys., A.

It is shown that a quasiclassical approximation exactly describes the spectroscopy of excited states of a nonrelativistic one-dimensional hydrogen atom. In the relativistic region, the quasiclassical approximation correctly predicts only one of two series of the exact theory. Sources of inaccuracy of quasiclassical results are revealed for the relativistic case. 15 refs.

42129 (JINR-R-5-89-322) **On the existence of a solution of the Cauchy problem and stability of some solutions for the nonlinear Schroedinger equation.** Zhidkov, P.E. Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics. 1989. 7p. (In Russian). Order Number DE90631605. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

Submitted to Mat. Modelirovanie.

The nonlinear Schroedinger equation $iu_t+u_{xx}+f((u)^2)u=0$, $u(x, 0)=u_0(x)$ is considered. First, some theorems are proved about existence and uniqueness of a solution for the problem which are needed for the stability. The results of the other authors paper are used. Then, the stability of the solutions $F(x,t)=a_0 \exp if(a_0^2)t$ is investigated. The stability condition is $f'(a_0^2) < 0$. 15 refs.

42130 (JINR-R-11-89-191) **Asymptotic estimates of approximation errors by the Galerkin method for one class of quasipotential equations.** Zhidkov, E.P. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Computing Techniques and Automation); Khoromskij, B.N.; Nikonov, Eh.G. Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Computing Techniques and Automation. 1989. 14p. (In Russian). Order Number DE90631600. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

In eigenvalue problem for one class of quasipotential integral equations the approximation error estimates by Galerkin's method have been obtained. For completely continuous integral operators the conditions have been obtained when numerical solution error of eigenvalue problem is presented as a series over parameter r^{-1}, where r is the length of discretization interval for operator determined on a semiaxis. 21 refs.

42131 (N-90-20650) **High order filtering methods for approximating hyberbolic systems of conservation laws. Final report.** Lafon, F.; Osher, S. National Aeronautics and Space Administration, Hampton, VA (USA). Inst. for Computer Applications in Science and Engineering. Mar 1990. 37p. (NASA-CR-182016;NAS-1.26:182016;ICASE-90-25). Available from NTIS, PC A03/MF A01.

In the computation of discontinuous solutions of hyperbolic systems of conservation laws, the recently developed essentially non-oscillatory (ENO) schemes appear to be very useful. However, they are computationally costly compared to simple central difference methods. A filtering method which is developed uses simple central differencing of arbitrarily high order accuracy, except when a novel local test indicates the development of spurious oscillations. At these points, the full ENO apparatus is used, maintaining the high order of accuracy, but removing spurious oscillations. Numerical results indicate the success of the method. High order of accuracy was obtained in regions of smooth flow without spurious oscillations for a wide range of problems and a significant speed up of generally a factor of almost three over the full ENO method.

42132 (N-90-20768) **Cell averaging Chebyshev methods for hyperbolic problems. Final report.** Wei, C.; Gottlieb, D.; Harten, A. National Aeronautics and Space Administration, Hampton, VA (USA). Inst. for Computer Applications in Science and Engineering. Mar 1990. 23p. (NASA-CR-182028;ICASE-90-27;NAS-1.26:182028). Available from NTIS, PC A03/MF A01.

A cell averaging method for the Chebyshev approximations of first order hyperbolic equations in conservation form is described. Formulas are presented for transforming between pointwise data at the collocation points and cell averaged quantities, and vice-versa. This step, trivial for the finite difference and Fourier methods, is nontrivial for the global polynomials used in spectral methods. The cell averaging methods presented are proven stable for linear scalar hyperbolic equations and present numerical simulations of shock-density wave interaction using the new cell averaging Chebyshev methods.

42133 (SAND-90-1266) **SuperCHIEF: A modified CHIEF [Combined Helmholz Integral Equation Formulation] method.** Segalman, D.J.; Lobitz, D.W. Sandia National Labs., Albuquerque, NM (USA). Jul 1990. 21p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. Order Number DE90014744. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

When the boundary integral equation method is applied to exterior acoustics problems, singularities occur in the resulting algebraic equations at various frequencies associated with the eigenvalues of an interior problem. These frequencies are referred to as "forbidden," and various methods have been devised to overcome the computational difficulties presented at these frequencies. The work presented here is an extension to the CHIEF method in that higher derivatives, in addition to the function itself, are constrained to be zero at selected points in the interior domain. Whereas the relative success of either method depends on the quantity and selection of interior points, the SuperCHIEF method requires fewer interior points and is less sensitive to point selection, resulting in improved robustness without significant increase in computational complexity. 3 refs., 14 refs.

42134 (UCRL-ID-104183) **The FAR codes.** Barth, M.J.; Ziolkowski, R. Lawrence Livermore National Lab., CA (USA). 7 Jun 1990. 358p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. Order Number DE90014729. Available from NTIS, PC A16/MF A01 - OSTI; GPO Dep.

The FAR code models in the time and frequency domains, the far fields resulting from electromagnetic fields generated in complex near field environments. There are three versions of the code, a stand-alone version and two post-processor versions (time histories and frequency patterns) which model the far fields of the outputs from finite difference time domain codes. This report covers the formula development, code construction, code validation, and error sources of the code. The errors which may be mitigated, but not eliminated, are the grid sampling error, the magnetic field adjustment error, and the discrete Fourier transform (DFT) errors. Only the last error occurs with the stand-alone version. The grid sampling error is inversely proportional to the number of sampling points per square wavelength and is mitigated by using a finer mesh. The magnetic field adjustment error is mitigated by using a two point spatial averaging and a three point time interpolation. The DFT errors are aliasing, leakage, and picket-fence errors. They are mitigated by using a transit pulse with reduced high frequency content and using a zero packing technique in the DFT routine. 19 refs., 293 figs., 44 tabs.

42135 (UCRL-ID-104253) **Approximate Heisenberg operator calculation of strong-field ionization.** Ritchie, B. Lawrence Livermore National Lab., CA (USA). 1 Jun 1990. 14p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. Order Number DE90014723. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The Schroedinger equation is integrated in space and time to calculate the photoionization dynamics of a generic one-dimensional model in a strong, monochromatic field. These results are compared against approximate Heisenberg operator calculations, and generally good agreement is obtained. Since the Heisenberg operator for the electric position is approximated by a classical trajectory, this results shows how to use classical dynamics to simulate Schroedinger wave-packet dynamics. 3 figs.

42136 (UWThPh–1990-2) **Dynamics of unstable systems.** Posch, H.A. (Vienna Univ. (Austria). Inst. fuer Experimentalphysik); Narnhofer, H.; Thirring, W. Vienna Univ. (Austria). Inst. fuer Theoretische Physik. 16 Mar 1990. 31p. (UWExpPh–1990-3). Order Number DE90631608. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

We study the dynamics of classical particles interacting with attractive Gaussian potentials. This system is thermodynamically not stable and exhibits negative specific heat. The results of the computer simulation of the dynamics are discussed in comparison with various theories. In particular, we find that the condensed phase is a stationary solution of the Vlasov equation, but the Vlasov dynamics cannot describe the collapse. 14 refs., 1 tab., 11 figs. (Authors).

42137 (UWThPh–1990-4) **Entropic and algebraic K-systems: A comparison.** Benatti, F. Vienna Univ. (Austria). Inst. fuer Theoretische Physik. 21 Mar 1990. 13p. Order Number DE90631610. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

In the quantum, i.e. non-commutative case, algebraic K-systems and entropic K-systems must be distinguished. The similarities and differences between them are considered, especially with regard to clustering- and mixing properties. 14 refs.

42138 (UWThPh–1990-11) **Relative log-concavity of ground state wave functions and spectral shifts of Schroedinger operators: A generalized simpler proof.** Baumgartner, B. Vienna Univ. (Austria). Inst. fuer Theoretische Physik. 8 Mar 1990. 6p. Order Number DE90631607. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

The logarithmic convexity or concavity of a ground state wave function divided by a comparison function is an essential tool in deriving theorems on level ordering and inequalities for scattering phase shifts. The simple proof, which A. Martin gave for comparison with Coulomb systems, is generalized in two ways. The logarithmic convexity property can now be proved in a simple way also in comparison with other systems, not only hydogen atom, and for functions, which are solutions of the Schroedinger equation but not square integrable. 7 refs. (Author).

42139 (UWThPh–1990-13) **Einstein's relativity theory and its relevance to recent cosmology.** Aichelburg, P.C. Vienna Univ. (Austria). Inst. fuer Theoretische Physik. 1990. 13p. (In German). Order Number DE90631623. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The Newtonian physics is based on absolute time and absolute space, simultaneity is unique and universal. In the Special Relativity the concept of absolute simultaneity is abandoned and time is dependent on the motion state. But both in Newtonian physics and Special Relativity time and space form a rigid background for the dynamics of matter. In General Relativity space and time are incorporated into the dynamics. The geometrical behaviour of bodies and the pace of clocks is dependent on space-time geometry which in turn is influenced by matter. In cosmology this mutual influence is driven to the extreme. Space-time is 'created together with matter'. Geometry is determined by the matter contained in the space. 14 refs., 5 figs. (Author, transl.).

42140 (UWThPh–1990-14) **On the spherical symmetry of static perfect fluids in general relativity.** Beig, R.; Simon, W. Vienna Univ. (Austria). Inst. fuer Theoretische Physik. 4 Apr 1990. 6p. Order Number DE90631624. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

We present a theorem which establishes uniqueness, in particular spherical symmetry, of a wide class of general relativistic, static perfect-fluid models provided there exists a spherically symmetric model with the same equation of state and surface potential. The method of proof, which is inspired by recent work of Masood-ul-Alam, is illustrated by demonstrating uniqueness of a class of solutions due to Buchdahl which correspond to an extreme case of the inequality on the equation of state required by our theorem. 16 refs. (Authors).

42141 (UWThPh–1990-20) **Information-theoretical aspects of quantum-mechanical entropy.** Wehrl, A. Vienna Univ. (Austria). Inst. fuer Theoretische Physik. 3 May 1990. 13p. Order Number DE90631609. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Properties of the quantum (= von Neumann) entropy $S(\rho) = -k\,\mathrm{Tr}\,\rho \ln\rho$, ρ being a compact operator, are proved first, and differences against the classical case, e.g. the Shannon entropy, are worked out. The main result is on the strong subadditivity of this quantum entropy. Then another entropy, a function not of the state but of the dynamics of the system, is considered as a quantum analogue of the classical Kolmogorov-Sinai-entropy. An attempt in defining such a quantity had only recently sucess in a paper of Connes, Narnhofer and Thirring. A definition of this entropy is given. 34 refs.

42142 **Exact equivalence of spin-1/2 Aharonov-Bohm and Aharonov-Casher effects.** Hagen, C.R. (Department of Physics and Astronomy, University of Rochester, Rochester, New York 14627 (USA)). *Physical Review Letters (USA)*, 64(20): 2347-2349 (14 May 1990). DOE Contract AC02-76ER13065.

It is shown that there is an exact equivalence between the Aharonov-Bohm effect for spin-1/2 particles and the Aharonov-Casher effect. The demonstration of this precise relationship between the two is seen furthermore to be independent of whether relativistic or nonrelativistic kinematics are used. The only remaining substantive distinction between the two effects may well be the fact that the scattering cross section for polarized beams has a considerably greater sturcture in the Aharonov-Casher case despite the mathematical equivalence of the scattering amplitudes for the two effects.

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Refer also to citation(s) 41827

42143 (AD-A–220123/4/XAB) **Investigation of the effect of mechanical stress on cold fusion. Master's thesis.** Wohl, B.H. Air Force Inst. of Tech., Wright-Patterson AFB, OH (USA). School of Engineering. Mar 1990. 68p. (AFIT/GNE/ENP–90M-8). Available from NTIS, PC A04/MF A01.

The purpose of this research was to see if the phenomenon known as cold fusion could be observed after loading a sample of titanium with deuterium gas and then subjecting the sample to mechanical stress. Samples of commercially pure titanium were loaded with deuterium by heating them inductively to 643 + or - 4 C while they were in a deuterium atmosphere. After loading, the samples were subjected to either dynamic tensile stress, a static load, or shear stress. The samples were surrounded by a 4-pi neutron detector during the application of stress and data from the detection system was analyzed for either large bursts of neutrons or continuous low-level emission of neutrons. Despite the fact that the neutron detection system was sensitive to certain environmental factors, application of tensile stress caused no positive indications of cold fusion. One suspiciously large count did occur during the application of shear stress, but that part of the experiment was relatively uncontrolled, and it is believed that the one large count was caused by environmental factors. An upper limit of 1.2 x 10 to the -24th power neutrons/deuteron pair/s has been calculated for the samples involved in the research. This is based on the limits of sensitivity of the neutron detection system.

42144 (LRP–403/90) **Papers contributed to the 17th EPS conference on controlled fusion and plasma heating, Amsterdam, The Netherlands, June 1990.** Ecole Polytechnique Federale, Lausanne (Switzerland). Centre de Recherche en Physique des Plasma (CRPP). Jun 1990. 60p. (In Russian). (CONF-900602–: 17. European conference on controlled fusion and plasma heating, Amsterdam (Netherlands), 25-29 Jun 1990).

Order Number DE90706116. Available from NTIS (US Sales Only), PC A04/MF A01; OSTI; INIS.

Individual papers are indexed separately.

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Refer also to citation(s) 41010, 41167, 41770, 41793, 41803, 41804, 42245

42145 (ANL/FPP/TM–248) **Simulations of ICRF-fast wave current drive on DIIID.** Ehst, D.A. Argonne National Lab., IL (USA). Fusion Power Program. Jun 1990. 18p. Sponsored by U.S. DOE Energy Research. DOE Contract W-31109-ENG-38. Order Number DE90013634. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

Self-consistent calculations of MHD equilibria, generated by fast wave current drive and including the bootstrap effect, were done to guide and anticipate the results of upcoming experiments on the DIIID tokamak. The simulations predict that 2 MW of ICRF power is more than adequate to create several hundred kiloamperes in steady state; the total current increases with the temperature and density of the target plasma. 12 refs., 12 figs., 1 tab.

42146 (CONF-900602–16) **The effect of the induced RF current density profile during lower-hybrid current drive on the evolution of the q profile and sawteeth stabilization.** Shoucri, M. (Centre Canadien de Fusion Magnetique, Varennes, PQ (Canada)); Shkarofsky, I.P.; Jardin, S.; Kritz, A. City Univ. of New York, NY (USA); Centre Canadien de Fusion Magnetique, Varennes, PQ (Canada). [1990]. 4p. Sponsored by U.S. DOE Energy Research. DOE Contract FG02-84ER53187. From 17. European conference on controlled fusion and plasma heating; Amsterdam (Netherlands); 25-29 Jun 1990. Order Number DE90014046. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

Short communication. LOWER HYBRID CURRENT DRIVE/ sawtooth oscillations; TOKAMAK DEVICES/lower hybrid current drive; CURRENT DENSITY; PLASMA SIMULATION; RF SYSTEMS; STABILITY

42147 (CONF-900602–17) **Combined electron cyclotron ray tracing and transport code studies in the Compact Ignition Tokamak.** Bonoli, P.T. (Massachusetts Inst. of Tech., Cambridge, MA (USA). Plasma Fusion Center); Englade, R.C.; Porkolab, M.; Kritz, A.H. Hunter Coll., New York, NY (USA). [1990]. 4p. Sponsored by U.S. DOE Energy Research. DOE Contract FG02-84ER53187. From 17. European conference on controlled fusion and plasma heating; Amsterdam (Netherlands); 25-29 Jun 1990. Order Number DE90014097. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

The Compact Ignition Tokamak (CIT) operating scenario is envisaged to consist of a start-up phase in which the toroidal magnetic field (B_T), plasma current (I_P) and central electron density ($n_e(0)$) are simultaneously ramped, followed by a burn cycle and a ramp down cycle. Electron cyclotron radio-frequency (ECRF) power at fixed frequency is ideally suited to heating during the ramp up phase of CIT. The angle of injection of the incident microwave beam can be varied as the toroidal field is ramped, so as to maintain central rf-power deposition. Furthermore, since the EC wave is a propagating mode in vacuum, relatively high power densities can be easily coupled into a compact device. Finally, we note that recent advances in source technology makes ECR heating at (280–310) GHz a viable option. In order to realistically simulate this ramp up scenario, a combined code has been developed in which ECRF ray tracing and absorption, and MHD equilibrium calculation, and thermal and particle transport are treated self-consistently. Previous studies of electron cyclotron resonance heating in CIT were carried out using model profiles of rf absorption based on stand-alone ray tracing and absorption calculations. In addition, these studies held the plasma current, toroidal magnetic field, and density constant in time. In the present work, a time variation in these plasma quantities is imposed and ECRF power deposition is re-calculated during rf injection so as to more realistically and self-consistently simulate ECH-assisted start-up in CIT. The most recent CIT configuration calls for a toroidal field ramp to 11T. Thus, the present studies consider the use of an ECRF source frequency of 308 GHz, with EC waves launched in the ordinary mode of polarization.

42148 (DOE/ER/53198–156) **Transport and fluctuation in reversed field pinches.** Prager, S.C. Wisconsin Univ., Madison, WI (USA). Jun 1990. 13p. Sponsored by U.S. DOE Energy Research. DOE Contract FG02-85ER53198. (CONF-900602–19: 17. European conference on controlled fusion and plasma heating, Amsterdam (Netherlands), 25-29 Jun 1990). Order Number DE90013641. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

In the reversed field pinch various turbulent transport mechanisms might be simultaneously active, including MHD flow effects, free- streaming in a stochastic magnetic field, direct transfer of fluctuating energy to ions, and electrostatic fluctuation driven transport. By comparing fluctuations and transport in the RFP to that in the related toroidal configurations of the tokamak and stellarator, a greater understanding of toroidal confinement in general might be achieved. In addition to particle and energy transport, current tranport sustains the reversed field magnetic configuration and constitutes the dynamo effect. Recent results are available from RFP experiments on electrostatic fluctuations, anomalous ion heating, the presence of free-streaming fast electrons, and the extension of these effects to plasmas of large size. The reactor promise of the RFP is based upon the conjecture that the beta value will remain high and the resistance scaling classical, as has been the case in past experiments. One might expect beta to be limited by resistive interchange turbulence. The MST, RFX, and ZTH experiments will form a sequence of devices to test this scaling conjecture to large size and large current values.

42149 (DOE/ER/53198–159) **Total magnetic reconnection during a tokamak major disruption.** Goetz, J.A.; Dexter, R.N.; Prager, S.C. Wisconsin Univ., Madison, WI (USA). Dept. of Physics. Jul 1990. 8p. Sponsored by U.S. DOE Energy Research. DOE Contract FG02-85ER53198. Order Number DE90014711. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

The safety factor within a tokamak plasma has been measured during a major disruption. During the disruption, the central safety factor jumps from below one to above one, while the total current is unchanged. This implies that total reconnection has occurred. This observation is in contract to the absence of total reconnection observed during a sawtooth oscillation in the same device. 11 refs., 6 figs.

42150 (DOE/ET/53088–338) **Stochastic and collisional diffusion in two-dimensional periodic flows.** Doxas, I. (Colorado Univ., Boulder, CO (USA). Dept. of Astrophysical, Planetary, and Atmospheric Sciences); Horton, W.; Berk, H.L. Texas Univ., Austin, TX (USA). Inst. for Fusion Studies. May 1990. 16p. Sponsored by U.S. DOE Energy Research. DOE Contract FG05-80ET53088. (IFSR–338). Order Number DE90014335. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

The global effective diffusion coefficient D* for a two-dimensional system of convective rolls with a time dependent perturbation added, is calculated. The perturbation produces a background diffusion coefficient D, which is calculated analytically using the Menlikov-Arnold integral. This intrinsic diffusion coefficient is then enhanced by the unperturbed flow, to produce the global effective diffusion coefficient D*, which we can calculate theoretically for a certain range of parameters. The theoretical value agrees well with numerical simulations. 23 refs., 4 figs.

42151 (DOE/ET/53088–431) **Temperature-gradient instability induced by conducting end walls.** Berk, H.L. (Texas Univ., Austin, TX (USA). Inst. for Fusion Studies); Ryutov, D.D.; Tsidulko, Yu.A. Texas Univ., Austin, TX (USA). Inst. for Fusion Studies. Apr 1990. 27p. Sponsored by U.S. DOE Energy Research. DOE Contract FG05-80ET53088. (IFSR–431). Order Number DE90014334. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

A new rapidly growing electron temperature gradient instability is found for a plasma in contact with a conducting wall. The linear instability analysis is presented and speculations are given for its nonlinear consequences. This instability illustrates that conducting walls can produce effects that are detrimental to plasma confinement. This mode should be of importance in open-ended systems

including astrophysical plasmas, mirror machines and at the edge of tokamaks where field lines are open and are connected to limiters or divertors. 16 refs., 2 figs.

42152 (EUR-CEA-FC–1987-88) **The 1987-1988 progress report of the CEA-Euratom Association Research Laboratory.** Association Euratom-CEA, Centre d'Etudes Nucleaires de Grenoble, 38 (France). Dept. de Recherches sur la Fusion Controlee. May 1989. 58p. (In French). Available from NTIS (US Sales Only), PC A04/MF A01.

The progress report of the CEA-Euratom Association Research Group, concerning 1987 and 1988 activities, is presented. The report involves the work carried out for assembling the Tore Supra system. The different components and the operating modes are described. The report includes: the Tore Supra construction and running, theoretical work, numerical calculations and results, the tritium technology, safety studies, supraconductors and bobbins. The Tore Supra contributions to the JET program are given.

42153 (FRCEA-TH–272) **Suprathermal Ions confinement in a non axisymmetric tokamak.** Grua, P. Association Euratom-CEA, Centre d'Etudes Nucleaires de Cadarache, 13 - Saint-Paul-lez-Durance (France). Dept. de Recherches sur la Fusion Controlee; Aix-Marseille-1 Univ., 13 - Marseille (France). 1989. 202p. (In French). Order Number DE90508411. Available from NTIS (US Sales Only), PC A10/MF A01.

In a tokamak, the toroidal magnetic field exhibits a ripple due to the finite coils number. In this work, the effects of this non axisymmetric perturbation on suprathermal ions (fast ions generated by additional heating or charged fusion products) are investigated. If the ripple is high enough to create local magnetic wells along trajectories, a non diffusive transport process due to trapping in this wells occurs and lead to direct particle losses. Such a situation can be encountered during future neutral beam injection experiments in the TORE-SUPRA tokamak. We have elaborated a Fokker-Planck transport code and numerical results indicate high fast ion losses. In order to minimize these losses, various methods are proposed and analyzed. On the other hand, when the ripple is weak (no local wells), an hamiltonian description of the particle interaction with the perturbation lead to identify a stochastic instability due to a resonance overlapping. We give two distinct stochasticity criterions which are associated with two diffusion regimes. For alpha particles in a reactor sized tokamak, we evaluate stochastic thresholds and diffusion coefficients.

42154 (GA-A–20057) **Experiments at high elongations in DIII-D.** Lazarus, E.A. (Oak Ridge National Lab., TN (USA)); Turnbull, A.D.; Kellman, A.G.; Ferron, J.R.; Helton, F.J.; Lao, L.L.; Leuer, J.A.; Strait, E.J.; Taylor, T.S. General Atomics, San Diego, CA (USA). Jun 1990. 4p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-89ER51114 ;AC05-84OR21400. (CONF-900602–12: 17. European conference on controlled fusion and plasma heating, Amsterdam (Netherlands), 25-29 Jun 1990). Order Number DE90013217. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

In this paper we discuss the limitation to elongation observed in D-shaped plasmas in the DIII-D tokamak. We find that as the triangularity is increased and ℓ_i is decreased that the n = 0 mode takes on an increasingly non-rigid character. Our analysis shows two aspects of the behavior; first, an increasing variation of the m/n = 1/0 component across flux surfaces and second, an increase in the relative amplitude of a m/n = 3/0 component which couples to the m/n = 1/0 component and further destabilizes the mode.

42155 (GA-A–20058) **Comparison of thermal and angular momentum transport in neutral beam-heated hot-ion H- and L-mode discharges in DIII-D.** Burrell, K.H. (General Atomics, San Diego, CA (USA)); Groebner, R.J.; Carlstrom, T.N.; Lohr, J.; Sager, G.; St. John, H.; Seraydarian, R.P.; Schissel, D.P.; Kurki-Suonio, T.; Matsumoto, M. General Atomics, San Diego, CA (USA). Jun 1990. 4p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-89ER51114. (CONF-900602–18: 17. European conference on controlled fusion and plasma heating, Amsterdam (Netherlands), 25-29 Jun 1990). Order Number DE90014121. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

We have carried out experiments using the hot-ion mode of operation to compare the bulk transport in L-mode and H-mode discharges. These experiments have demonstrated that the confinement improvement in the bulk of the plasma in DIII-D is due to a simultaneous improvement in electron and ion energy transport. In addition, the magnitude of electron and ion thermal diffusivities and angular momentum diffusivity as well as the change in these quantities between L- and H-mode have allowed us to place significant constraints on theories of tokamak transport. Although the most obvious improvement in confinement at the L to H transition occurs at the plasma edge, there is also a significant improvement in local energy transport throughout the plasma. Most of the previous experiments in this area made their comparison between L-mode and H-mode plasmas at significantly different densities. This could have affected the results if the local transport depends on density. The work by Jahns, et al. was done at the same line-averaged density; they still found a significant improvement in local transport, although they were not able to determine whether the improvement occurred in the electron or ion channel. We have extended the work of Jahns. et al. to hot-ion conditions where we can separately study the power flow in the electron and ion channels. We have made detailed comparisons of energy and angular momentum transport between deuterium L- and H-mode plasmas with the same density (3.5×10^{19} m^{-3}), the same current (1 MA), the same toroidal field (2.1 T), the same deuterium neutral beam input power (8.7 MW), and very similar internal flux surface shapes. 6 figs.

42156 (GA-A–20076) **Characteristics of toroidal energy deposition asymmetries in ASDEX.** Evans, T.E. (General Atomics, San Diego, CA (USA)); Neuhauser, J.; Leuterer, F.; Mueller, E.R. General Atomics, San Diego, CA (USA); Association Euratom-Max-Planck-Institut fuer Plasmaphysik, Garching (Germany, F.R.). Jul 1990. 15p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-89ER51114. (CONF-900505–8: 9. plasma surface interactions in controlled fusion devices conference, Bournemouth (UK), 20-25 May 1990). Order Number DE90014362. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

Large toroidal and poloidal asymmetries with characteristics which are sensitively dependent on q_a, the vertical position of the plasma, and the type of additional heating are observed in the energy flow to the ASDEX divertor target plates. The largest asymmetries and total energy depositions are observed during lower hybrid wave injection experiments with approximately 50% of the input energy going to the combined divertor targets and shields. A maximum localized energy density loading of 10 MJ/m^2 is typical under these conditions. Measurements of the asymmetries are consistent with a model in which magnetic islands and ergodicity due to intrinsic magnetic perturbations dominate the energy transport across the primary magnetic separatrix. These results emphasize the essential role of resonant magnetic perturbations in determining the performance of tokamaks and demonstrate that non-axisymmetric effects caused by small perturbations become increasingly important in determining the transport properties as the injected power is increased. 5 refs., 4 figs., 1 tab.

42157 (GA-A–20081) **Physics of the L to H transition in DIII-D.** Matsumoto, H. (Japan Atomic Energy Research Inst., Tokyo (Japan)); Burrell, K.H.; Carlstrom, T.N.; Gohil, P.; Groebner, R.J.; Mahdavi, M.A.; Osborne, T.H.; Doyle, E.J.; Lehecka, T.; Luhmann, N.C. Jr. General Atomics, San Diego, CA (USA). Jun 1990. 6p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-89ER51114. (CONF-900602–20: 17. European conference on controlled fusion and plasma heating, Amsterdam (Netherlands), 25-29 Jun 1990). Order Number DE90014120. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

A decrease in the edge magnetic and density fluctuations is always seen at the L-H transitions in DIII-D. Although H-mode is best known for an increase in energy confinement, in fact, the reduction in the edge fluctuations is one of the most reliable indicators of the L-H transition. In DIII-D, a sudden change of the perpendicular rotation, $V_\perp$ in the edge has been also observed at the transition. Recently, theories that fluctuations are reduced by sheared poloidal flow have been proposed to link these two observations. Also, a theory to explain the mechanism responsible for the observed

poloidal flow has been proposed. Experimental observations have thus far been consistent with these theories. 6 refs., 4 figs.

42158 (IAE–4708-6) **Development of axial-symmetric instability in a plasma cylinder with longitudinal current.** Ivkin, B.N.; Nikonov, S.V.; Solov'ev, L.S. Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow (USSR). Inst. Atomnoj Ehnergii. 1988. 23p. (In Russian). Order Number DE90631970. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The problem of the development of the axial-symmetrical instability in plasma cylinder with the longitudinal current is investigated by the method of numerical solution of the system of the equations of undissipated two-fluid electromagnetic gasodynamics. It is shown that the main phenomena, taking place on the final stage of a discharge in the systems of z-pinch type, are the consequence of process of the development of the considered instability. The formations of the condensed bunches of the dense hot plasma, generation of the electrical field and the acceleration of the charged particles along the axis of a discharge are concerned to this phenomena. 17 refs.; 9 figs.

42159 (IAE–4819-6) **Physics of beam-plasma discharge in a magnetic field.** Kurko, O.V.; Popkov, N.G. Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow (USSR). Inst. Atomnoj Ehnergii. 1989. 11p. (In Russian). Order Number DE90631932. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The time evolution model of the beam-plasma discharge in an axial magnetic field is investigated on the basis of the numerical solution of balance equations for electrons, ions, neutral atoms, average electron energy and for the density of the plasma wave energy. For low pressures the threshold of the discharge ignition is connected with the space charge neutralization condition for the beam. This threshold depends on the ion temperature. For constant beam currents the rise of the initial neutral pressure leads to steady states with the burnout of neutrals in the beam region. The further rise of the initial pressure of neutrals stops the burnout. For stationary states it corresponds to the phase transition with a sharp decrease of the average electron energy. 16 refs.; 2 figs.

42160 (IC–89/149) **Radiative thermal condensation instability in the presence of an electromagnetic wave.** Shukla, P.K.; Pant, H.C.; Jain, V.K. International Centre for Theoretical Physics, Trieste (Italy). Mar 1990. 7p. Order Number DE90631971. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

Radiative thermal condensation instability has been investigated in the presence of an electromagnetic wave in a uniform magnetized plasma. The relevance of our investigation to the formation of jets in a laser irradiated plasma has been discussed. (author). 6 refs.

42161 (ITF–87-146) **The scattering of electromagnetic ways in a plasma-molecular layer.** Golubinskij, P.K.; Zagorodnij, A.G.; Yakimenko, I.P. AN Ukrainskoj SSR, Kiev (Ukrainian SSR). Inst. Teoreticheskoj Fiziki. 1987. 41p. (In Russian). Order Number DE90631988. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

For plasma-molecular systems with plane-parallel boundaries the calculations of differential coefficients of incoherent scattering are made, taking into account thermal motion of charged particles and dynamics of molecular subsystem. Electromagnetic fields scattered on fluctuations in the layer of plasma-molecular system are calculated. General ratios for dynamic form-factors of the system considered in various frequency ranges are given. Certain results of numerical analysis of the characteristics, illustrating the main peculiarities of spectral and angular distributions of scattered radiation intensities related to the presence of layer boundaries, are also presented. 23 refs.; 13 figs.

42162 (ITF–87-151) **Multimode instability regimes of a strong-current electron beam in magnetized plasma.** Chernousenko, V.M.; Kuklin, V.M.; Panchenko, I.P. AN Ukrainskoj SSR, Kiev (Ukrainian SSR). Inst. Teoreticheskoj Fiziki. 1988. 13p. (In Russian). Order Number DE90631972. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Nonlinear dynamics of beam-plasma system instability for electron beams with small energy spread is analyzed. The paper focuses on studying the multimode regimes of beam instability. In the case of a strong-current beam the interaction between oscillations that belong to different oscillation branches is great. In the developed instability regime the modes of the most high-frequency oscillation branch of magnetized plasma which are close to resonance are primarily excited. 14 refs.; 6 figs.

42163 (ITF–87-169) **The role of dissipative processes in the evolution of non-equilibrium nonlinear distributed systems.** Kuklin, V.M.; Panchenko, I.P. AN Ukrainskoj SSR, Kiev (Ukrainian SSR). Inst. Teoreticheskoj Fiziki. 1988. 51p. (In Russian). Order Number DE90631973. Available from NTIS (US Sales Only), PC A04/MF A01; OSTI; INIS.

The influence of dissipative processes on the evolution of nonlinear nonequilibrium systems is investigated in the case of instability excitation with a finite region of wave numbers. The space and time dynamics of the instability is considered. It is shown that in the case of slow overthreshold system dissipative field strutures are possible. 62 refs.; 32 figs.

42164 (IYaF–88-99) **Kinetics of weakly turbulent wave fields.** Erofeev, V.I.; Malkin, V.M. AN SSSR, Novosibirsk (USSR). Inst. Yadernoj Fiziki. 1988. 59p. (In Russian). Order Number DE90631989. Available from NTIS (US Sales Only), PC A04/MF A01; OSTI; INIS.

Only the first nonvanishing term in the expansion of collision integral in powers of wave enrgy is usually considered. Nevertheless the highr collisional terms in the wave kinetic equation can be dominant in the energy range, where the turbulence still remains weak. These terms can be essential even when they are smaller than the first one, if they violate some of the conservation laws correct in the first approximation. The previous attempts to calculate higher nonlinear terms in the wave kinetic equation resulyed in divergencies. Up to now there was no effctive way to aliminate such divergencies. This problem is solved in the present paper with the help of the Wyld's diagram technique. As a result the structure of collision intgral is clear up in everly order of its power expansion in wave energy and conditions of a kinetic equation applicability are specified. Th cubic collisional term for waves with the decay dispersion law is calculated correctly as an example of application of this method. 15 refs.

42165 (IYaF–89-5) **Plasma MHD-stability in the system of axial-symmetrical magnetic mirrors.** Kuz'min, S.V. AN SSSR, Novosibirsk (USSR). Inst. Yadernoj Fiziki. 1989. 17p. (In Russian). Order Number DE90631974. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The mathematical technique to calculate plasma MHD-oscillations in the system of paraxial and nonparaxial magnetic mirrors is developd. The equilibrium of potential grooved oscillations in such a system, the method of numeric solution of this equation and the results of tests using the simpliest model, are described. An example of MHD-stability of the system of paraxial magnetic mirror and semicusp with parameters approaching actual parameters, is presented. 9 refs.; 5 figs.

42166 (IYaF–89-33) **Postcollaptical effects in strong Langmuir turbulence.** Malkin, V.M. AN SSSR, Novosibirsk (USSR). Inst. Yadernoj Fiziki. 1989. 24p. Order Number DE90631990. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The qualitative theory of Langmuir turbulence is constructed, which takes into account the postcollaptical effects. The spectra obtained for Langmuir waves and accelerated electrons differ substantially from those predicted earlier. An interesting feature of new spectra is their dependence on the collapse symmetry. 6 refs.

42167 (IYaF–89-36) **Langmuir-ion acoustic wave interaction: Pt. 3. Stochastic phenomena.** Buchel'nikova, N.S.; Matochkin, E.P. AN SSSR, Novosibirsk (USSR). Inst. Yadernoj Fiziki. 1989. 63p. (In Russian). Order Number DE90631991. Available from NTIS (US Sales Only), PC A04/MF A01; OSTI; INIS.

The numerical experiments (PIC-method) were made to study the stochastic phenomena in the interaction of Langmuir wave and ion-sound wave. In the first case the ion-sound wave is nonlinear,

in the second case it breaks. The conversion of the Langmuir wave on the ion-sound wave leads to the excitation of Langmuir wave modes. This leads to the evolution of the modulational instability. The damping of the electric field is determined by the trapping of the electrons by the main (β1) conversion modes and by the stochastic instability of the electron motion. It is shown that the evolution of the large scale stochasticity leads to the heating of the main part of the electrons. The energy is absorbed by the long tails of the distribution function due to the large scale stochasticity in the trapping regions of the modulational instability modes. 9 refs.; 28 figs.; 6 tabs.

42168 (IYaF–89-65) **On the role of sound in the strong Langmuir turbulence.** Malkin, V.M. AN SSSR, Novosibirsk (USSR). Inst. Yadernoj Fiziki. 1989. 6p. Order Number DE90631992. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

The main directions in the precision of the theory of strong Langmuir turbulence caused by the necessity of account of sound waves in plasma are preseted. In particular the effect of conversion of short-wave modulations in Langmuir waves induced by sound waves, are briefly described. 8 refs.

42169 (KFTI–88-15) **Impurity ion diffusion peculiarities in torsatrons.** Zolotukhin, A.V.; Shishkin, A.A. AN Ukrainskoj SSR, Kharkov (Ukrainian SSR). Fiziko-Tekhnicheskij Inst. 1988. 9p. (In Russian). Order Number DE90631964. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

Generalization of geometrical factor of impurity ion diffusion coefficient $1+2/t^2$ (where t - rotational transform angle) for torsatron systems is carried out. Geometrical factor is analyzed for URAGAN-2M, ATF-1, Heliotron-E systems. The role of magn tic field harmonic composition and magnetic surfaces function in decrease of impurity ion diffusion coefficient is shown. 9 refs.; 1 fig.; 1 tab.

42170 (KFTI–88-18) **Light pipes for submillimeter laser interferometers.** Berezhnyj, V.L.; Kononenko, V.I.; Epishin, V.A.; Maslov, V.A.; Ryabykh, V.N.; Svich, V.A.; Topkov, A.N. AN Ukrainskoj SSR, Kharkov (Ukrainian SSR). Fiziko-Tekhnicheskij Inst. 1988. 37p. (In Russian). Order Number DE90631959. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

An investigation is made into the propagation and conversion of submillimeter light in circular dielectric light pipes. The computation technique for the distribution of the complex field amplitude in dielectric light pipes has been developed and verified in experiments. Optimum conditions were found for the excitation of the light pipes by submillimeter laser light, and the empiric relation was derived for the EH_{11} - mode damping constant. The requirements for the adjustment and alignment of the laser, beam- and the pipe axes are presented. The dielectric cones are shown to be effective in the conversion of submillimeter laser light. The conditions are described of the optimum passage of a linearly polarized Gaussian beam through the light pipes examined. Novel focusing structures based on dielectric light pipes were devised which are characterized by simple design, low losses, and good focusing. 30 refs.; 14 figs.; 4 tabs.

42171 (LRP–399/90) **Single mode operation of a hybrid optically pumped D_2O far infrared laser.** Yuan, D.C. (Centre de Recherches en Physique des Plasmas, Lausanne (Switzerland)); Siegrist, M.R. Ecole Polytechnique Federale, Lausanne (Switzerland). Centre de Recherche en Physique des Plasma (CRPP). Apr 1990. 17p. Order Number DE90631933. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

We have achieved single mode operation in a hybrid optically pumped D_2O far infrared laser. The active volume of the resonator was divided into two sections separated by a thin plastic foil. The larger section served as the main gain medium and the shorter section as mode selective element. The vapor pressure in the smaller volume was either very low or alternatively about 3 times higher than the pressure in the main part. In both cases single mode operation was achieved without any reduction of the total output energy. (author) 13 refs., 7 figs.

42172 (LRP–401/90) **Central mass feedback control using the discrete Alfven wave spectrum.** Dudok de Wit, Th. (Centre de Recherches en Physique des Plasmas, Lausanne (Switzerland)); Lister, J.B.; Duval, B.P.; Joye, B.; Marmillod, Ph. Ecole Polytechnique Federale, Lausanne (Switzerland). Centre de Recherche en Physique des Plasma (CRPP). Apr 1990. 11p. Order Number DE90631934. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The dispersion relation of the shear Alfven wave depends on several internal plasma parameters, including the central effective mass. By frequency tracking a Discrete Alfven Wave during the plasma current flat-top, we obtained a real-time estimate of the central effective mass. Using the measured mass, we have been able to feedback control both the effective mass and the electron density of the plasma, using separately controllable hydrogen and deuterium filling valves. (author) 5 refs., 6 figs.

42173 (LRP–403/90, pp. 21-24) **Alfven wave heating in ASDEX.** Besson, G. (Centre de Recherches en Physique des Plasmas, Lausanne (Switzerland)); Borg, G.G.; Lister, J.B.; Marmillod, Ph.; Braun, F.; Murphy, A.B.; Noterdaeme, J.M.; Ryter, F.; Wesner, F. Ecole Polytechnique Federale, Lausanne (Switzerland). Centre de Recherche en Physique des Plasma (CRPP). Jun 1990. (CONF-900602–: 17. European conference on controlled fusion and plasma heating, Amsterdam (Netherlands), 25-29 Jun 1990). In *Papers contributed to the 17th EPS conference on controlled fusion and plasma heating, Amsterdam, The Netherlands, June 1990.* Order Number DE90706116. Available from NTIS (US Sales Only), PC A04/MF A01; OSTI; INIS.

An experiment has been completed on ASDEX to study the response of the plasma to Alfven wave heating (AWH). Antenna excitation was provided by the old TCA rf generator with an output power capability of 500 kW. Two poloidal loop antennas were installed at the east and west ends of the tokamak allowing either N=1 or N=2 phasings. Since the largest antenna coupling to the Alfven resonance is provided by the m=1 surface wave, the antenna consisted only of a single element on the low field side, whereas in TCA the antennas are located on the top and the bottom of the torus. The antenna elements consisted of 2 parallel bars of inductance 730 nH and, as in TCA, were left unshielded. A typical antenna circulating current of 2 kA peak at 1.80 MHz was provided for the experiments. (author) 3 refs., 4 figs.

42174 (LRP–403/90, pp. 41-44) **Ion temperature measurements in the TCA tokamak by collective Thomson scattering.** Siegrist, M. (Centre de Recherches en Physique des Plasmas, Lausanne (Switzerland)); Behn, R.; Duval, B. Ecole Polytechnique Federale, Lausanne (Switzerland). Centre de Recherche en Physique des Plasma (CRPP). Jun 1990. (CONF-900602–: 17. European conference on controlled fusion and plasma heating, Amsterdam (Netherlands), 25-29 Jun 1990). In *Papers contributed to the 17th EPS conference on controlled fusion and plasma heating, Amsterdam, The Netherlands, June 1990.* Order Number DE90706116. Available from NTIS (US Sales Only), PC A04/MF A01; OSTI; INIS.

Collective Thomson scattering, using a high-power pulsed D_2O laser at 385 μm and a heterodyne receiver system, has provided local ion temperature (T_i) measurements of the plasma in the TCA tokamak. Recent improvements in the noise-equivalent power (NEP) of the Schottky barrier diode mixers permitted us to achieve a typical precision of $\pm$12% for a single shot measurement at densities above 10^{20} m^{-3}. Even at densities of standard TCA discharges ($5x10^{19}$ m^{-3}) the uncertainty is better than $\pm$25%. For the interpretation of the measured spectra and the evaluation of T_i the local value of the electron temperature (T_e) is an important parameter. Therefore, T_e was measured simultaneously by incoherent Thomson scattering at 0.694 μm during a series of shots. The density was obtained from a far-infrared interferometer. An independent measurement of T_i on TCA can be obtained from a neutral particle analyzer (NPA). Comparison of the results from the two methods showed good agreement. The precision of a T_i-measurement depends strongly on the plasma density. Since an uncertainty of $\pm$ 25% at standard densities may still not be regarded as satisfactory, further investigations using a numerical simulation code have been carried out to find ways of improvement. (author) 1 ref., 3 figs., 1 tab.

42175 (LRP–403/90, pp. 49-52) **Ion cyclotron wave excitation by double resonance parametric coupling.** Fasoli, A. (Centre de Recherches en Physique des Plasmas, Lausanne (Switzerland)); Good, T.N.; Paris, P.J.; Skiff, F.; Tran, M.Q. Ecole Polytechnique Federale, Lausanne (Switzerland). Centre de Recherche en Physique des Plasma (CRPP). Jun 1990. (CONF-900602–: 17. European conference on controlled fusion and plasma heating, Amsterdam (Netherlands), 25-29 Jun 1990). In *Papers contributed to the 17th EPS conference on controlled fusion and plasma heating, Amsterdam, The Netherlands, June 1990.* Order Number DE90706116. Available from NTIS (US Sales Only), PC A04/MF A01; OSTI; INIS.

The term Double Resonance indicates generally a non-linear coupling between an electron plasma resonance (in our case, the Upper Hybrid, UH) and a low frequency eigenmode (typically, in a magnetized plasma, the ion cyclotron mode). The modulated parametric decay has been investigated in the past, both in theory and in experiments, mostly in the context of plasma heating, in order to decrease the power threshold required in the case of a monochromatic pump wave. More recently, renewed interest has been shown in connection with experiments on large scale modification of the ionosphere. In the experiment reported herein, we studied the modulated UH resonance as an internal antenna for Electrostatic Ion Cyclotron (EIC) waves. A method for a selective excitation of the Bernstein mode, based on the choice of the modulation excursion, is proposed. (author) 8 refs., 5 figs.

42176 (LRP–403/90, pp. 45-48) **Transition to high density discharges through hard gas puffing.** Nieswand, CH. (Centre de Recherches en Physique des Plasmas, Lausanne (Switzerland)); Pietrzyk, Z.A.; Pochelon, A.; Behn, R.; Knight, A. Ecole Polytechnique Federale, Lausanne (Switzerland). Centre de Recherche en Physique des Plasma (CRPP). Jun 1990. (CONF-900602–: 17. European conference on controlled fusion and plasma heating, Amsterdam (Netherlands), 25-29 Jun 1990). In *Papers contributed to the 17th EPS conference on controlled fusion and plasma heating, Amsterdam, The Netherlands, June 1990.* Order Number DE90706116. Available from NTIS (US Sales Only), PC A04/MF A01; OSTI; INIS.

For certain experiments, and to improve plasma performance, high values of plasma density are required. The density limit for quasi stationary discharges (QSD), with soft gas puffing, is approximately $5x10^{19}$ m^{-3} in the TCA tokamak. We have observed, however, that higher line average densities, above 10^{20} m^{-3}, can be obtained by hard gas puffing. When this hard puffing is followed by a gentle decrease of the gas flux, reproducible discharges without disruption can be obtained. In these discharges the density limit achieved $n_eR/B_t = 3.9x10^{19}$ $m^{-2}T^{-1}$ (for $q_a = 3.2$), was similar to that found in a similar sized machine and to that observed in JET. The Troyon β_{tor} limit, which for TCA at $q_a = 3.2$, is 1.3%, was closely approached at the end of these discharges near the density limit. All of the data to be presented were obtained on TCA with boronized walls at constant plasma current and with $q_a = 3.2 \pm 0.1$, although it is believed that the main features do not depend on the treatment of the walls. (author) 7 refs., 4 figs.

42177 (LRP–403/90, pp. 37-40) **Effects of boronisation on the plasma parameters in TCA.** Dudok de Wit, Th. (Centre de Recherches en Physique des Plasmas, Lausanne (Switzerland)); Duval, B.P.; Hollenstein, Ch.; Joye, B. Ecole Polytechnique Federale, Lausanne (Switzerland). Centre de Recherche en Physique des Plasma (CRPP). Jun 1990. (CONF-900602–: 17. European conference on controlled fusion and plasma heating, Amsterdam (Netherlands), 25-29 Jun 1990). In *Papers contributed to the 17th EPS conference on controlled fusion and plasma heating, Amsterdam, The Netherlands, June 1990.* Order Number DE90706116. Available from NTIS (US Sales Only), PC A04/MF A01; OSTI; INIS.

Wall conditioning and deposition of low Z materials on the first wall and limiters play an important role in plasma impurity control. Carbon film deposition (carbonisation) is already used on many Tokamaks. As proposed by Veprek, a film containing boron and carbon would be more resistant to chemical erosion and could also getter the oxygen. This procedure (boronisation) has been tried on Textor, Asdex and recently on TCA. The TCA vacuum vessel, the 8 rf antenna groups and 4 antenna screens are stainless steel and there are 4 carbon limiters placed in one poloidal plane. (author) 6 refs., 3 figs.

42178 (LRP–403/90, pp. 1-4) **Influence of an X-point and its poloidal location on the ideal MHD stability of a quasi-circular tokamak.** Roy, A. (Centre de Recherches en Physique des Plasmas, Lausanne (Switzerland)); Troyon, F. Ecole Polytechnique Federale, Lausanne (Switzerland). Centre de Recherche en Physique des Plasma (CRPP). Jun 1990. (CONF-900602–: 17. European conference on controlled fusion and plasma heating, Amsterdam (Netherlands), 25-29 Jun 1990). In *Papers contributed to the 17th EPS conference on controlled fusion and plasma heating, Amsterdam, The Netherlands, June 1990.* Order Number DE90706116. Available from NTIS (US Sales Only), PC A04/MF A01; OSTI; INIS.

The effect of a divertor on the ideal MHD stability of a quasi-circular single-null tokamak is investigated. Five different poloidal positions of the X-point are studied (inside and outside the torus, on the top of the section and two intermediate positions), and compared to an equivalent reference circular case. For low β plasmas, we compute the current limit imposed by the n=1 kink. The stable operating window, in the (q_0, q_{cyl}) plane, is also determined. The lower bound on q_{cyl} is found to be ≈ 1.2 for the divertor configuration. Then the β-limit at different values of the total current is considered. The maximum value of β set by the n=1 mode is comparable for each configuration, except when the X-point points upwards, in which case the maximum is roughly doubled. The results of the ballooning optimization are also presented for the five divertor configurations and for the reference circular case. (author) 6 refs., 7 figs., 1 tab.

42179 (LRP–403/90, pp. 9-12) **Global ideal MHD stability of 3D plasmas with pseudo-vacuum treatment for free-boundary modes.** Schwenn, U. (Max-Planck-Institut fuer Plasmaphysik, Garching (Germany, F.R.)); Anderson, D.V.; Cooper, W.A.; Gruber, R.; Merazzi, S. Ecole Polytechnique Federale, Lausanne (Switzerland). Centre de Recherche en Physique des Plasma (CRPP). Jun 1990. (CONF-900602–: 17. European conference on controlled fusion and plasma heating, Amsterdam (Netherlands), 25-29 Jun 1990). In *Papers contributed to the 17th EPS conference on controlled fusion and plasma heating, Amsterdam, The Netherlands, June 1990.* Order Number DE90706116. Available from NTIS (US Sales Only), PC A04/MF A01; OSTI; INIS.

The determination of the ideal MHD stability properties of plasma containment devices is never complete without the investigation of the impact that can be had by the class of instability that can displace the plasma-vacuum interface. These free-boundary modes impose in many cases the severest restrictions on the plasma beta that a configuration can achieve and/or the toroidal plasma current that can flow within it. In order to examine the free-boundary stability of a plasma, the potential energy contribution of the vacuum region that surrounds the plasma must be added to the internal contribution of the plasma itself. In two-dimensional (2D) plasmas, two methods have been developed to tackle the vacuum contribution to the energy principle. One scheme uses a Green's function technique which is particularly convenient when the conducting wall is placed at infinity. An alternative scheme is to treat the vacuum region as a pressureless and shearless pseudo-plasma. The main advantage of this scheme is that the structure of the problem in the vacuum region is identical to that in the plasma region. We have generalized the vacuum treatment as a pseudo-plasma to three-dimensional (3D) geometry and implemented it in the TERPSICHORE ideal MHD stability code, which was previously limited only to the study of internal structures. (author) 7 refs., 2 figs.

42180 (LRP–403/90, pp. 13-16) **Simulation of MHD activity during density limit disruptions in JET.** Parker, R. (Centre de Recherches en Physique des Plasmas, Lausanne (Switzerland)); Bondeson, A.; Hugon, M. Ecole Polytechnique Federale, Lausanne (Switzerland). Centre de Recherche en Physique des Plasma (CRPP). Jun 1990. (CONF-900602–: 17. European conference on controlled fusion and plasma heating, Amsterdam (Netherlands), 25-29 Jun 1990). In *Papers contributed to the 17th EPS conference on controlled fusion and plasma heating, Amsterdam, The Netherlands, June 1990.* Order Number DE90706116. Available from NTIS (US Sales Only), PC A04/MF A01; OSTI; INIS.

The operation of tokamaks is limited to densities below some threshold value which, in ohmic discharges, is proportional to the plasma current. When the density limit is exceeded, the discharge usually disrupts, because the profile contracts and becomes MHD unstable when the radiation losses equal, or exceed, the input power. Here, we report on a simulation study of density limit disruptions, in which radiation losses were specified according to experimental data from a disruption in JET. The MHD activity was simulated by a reduced-MHD code with a simple transport model. The simulations reproduce the sequence of events observed during density limit disruptions in JET, starting with m=3/n=1 activity, followed by strong growth of the m=2/n=1 mode, a sequence of minor disruptions, and finally a major disruption, in which the current profile flattens over almost the entire plasma, leading to a large drop in internal inductance, and an accompanying negative voltage spike. The simulations presented here give a scenario, different from that of previous theories, for the final phase of the disruption, including the so far ill-understood phase where the current profile broadens. 7 refs., 2 figs.

42181 (LRP–403/90, pp. 17-20) **Global, resistive stability analysis in axisymmetric systems.** Bondeson, A. (Centre de Recherches en Physique des Plasmas, Lausanne (Switzerland)); Luetjens, H.; Vlad, G. Ecole Polytechnique Federale, Lausanne (Switzerland). Centre de Recherche en Physique des Plasma (CRPP). Jun 1990. (CONF-900602–: 17. European conference on controlled fusion and plasma heating, Amsterdam (Netherlands), 25-29 Jun 1990). In *Papers contributed to the 17th EPS conference on controlled fusion and plasma heating, Amsterdam, The Netherlands, June 1990.* Order Number DE90706116. Available from NTIS (US Sales Only), PC A04/MF A01; OSTI; INIS.

Numerical codes such as ERATO and PEST have played an important role in developing the understanding of ideal-MHD stability for tokamaks. These codes solve the linearized ideal-MHD eigenvalue problem without any ordering assumptions. For resistive MHD, similar codes have been developed only recently. Under a collaboration between the CRPP Lausanne and ENEA Frascati, we have developed a resistive spectral code, MARS (MAgnetohydrodynamic Resistive Spectrum), for the full compressional MHD equations in two-dimensional geometry. Axisymmetric equilibria are computed by the cubic Hermite element code CHEASE, which allows specification of the pressure p and toroidal field, $T=RB_\Phi$, or the surface averaged toroidal current, $I'=<J_\Phi>$, as functions of the poloidal flux Ψ. The two codes use flux coordinates (s,χ,Φ), wher $s=(\Psi/\Psi_{edge})^{1/2}$ is the radial variable, Φ the geometrical toroidal angle, and χ the poloidal angle, specified by choosing the Jacobian, J. MARS Fourier decomposes the components of v and B in χ and uses a finite difference scheme in the radial direction. Here, we present results for a number of resistive instabilities where toroidal effects play an important role. All calculations are made with a fixed, and except where explicitly stated otherwise, circular boundary. (author) 9 refs., 4 figs.

42182 (LRP–403/90, pp. 53-58) **Ion wave excitation for the study of wave-induced transport.** Good, T.N. (Centre de Recherches en Physique des Plasmas, Lausanne (Switzerland)); Fasoli, A.; Skiff, F.; Anderegg, F.; Paris, P.J.; Tran, M.Q.; Rynn, N.; Stern, R.A.; Yamada, M. Ecole Polytechnique Federale, Lausanne (Switzerland). Centre de Recherche en Physique des Plasma (CRPP). Jun 1990. (CONF-900602–: 17. European conference on controlled fusion and plasma heating, Amsterdam (Netherlands), 25-29 Jun 1990). In *Papers contributed to the 17th EPS conference on controlled fusion and plasma heating, Amsterdam, The Netherlands, June 1990.* Order Number DE90706116. Available from NTIS (US Sales Only), PC A04/MF A01; OSTI; INIS.

A general program to study wave-particle interactions and wave-induced transport in a low temperature, low density, collisionless plasma has led to the application of an assortment of ion wave launching schemes. This wave launching techniques include the use of: capacitively coupled rings at the plasma periphery, inductive coils, grids immersed in the plasma, and ion wave excitation by modulation of microwaves (double resonance). The generated ion waves are either ion acoustic, the forward and backward (neutralized ion Bernstein) branches of electrostatic ion cyclotron, and/or ballistic modes. Our earlier studies have addressed the ion interaction with a single monochromatic wave, such as ion acceleration by intrinsic stochasticity induced by interaction with an ion Bernstein mode, and ion coordinate space diffusion constrained by conservation of integrals of the motion in this deterministic system. In the case of linear ion acoustic wave-particle interaction, an experimental test ion approach has yielded direct evidence of phase space orbit perturbations for ions resonant with the wave phase velocity, demonstrating on the kinetic level the essence of ion Landau damping. We are now turning our attention to the problem of stochastic interaction with two ion cyclotron modes. A detailed knowledge of the waves excited by the antenna will allow a selection of mode phase velocities such that the separation of wave-particle resonances can be controlled. In this way, the wave field amplitudes necessary for reaching the stochasticity threshold can be reduced, in comparison to the situation with one wave. This paper reviews the wave dispersion characteristics compiled during the aforementioned wave-particle interaction studies. It will be seen that the plasma dispersion relation universally determines the wave response, quite independent of the antenna configuration. (author) 9 refs., 4 figs.

42183 (LRP–403/90, pp. 25-28) **An experimental study of Alfven wave heating using electrostatically shielded antennas in TCA.** Borg, G.G. (Centre de Recherches en Physique des Plasmas, Lausanne (Switzerland)); Joye, B. Ecole Polytechnique Federale, Lausanne (Switzerland). Centre de Recherche en Physique des Plasma (CRPP). Jun 1990. (CONF-900602–: 17. European conference on controlled fusion and plasma heating, Amsterdam (Netherlands), 25-29 Jun 1990). In *Papers contributed to the 17th EPS conference on controlled fusion and plasma heating, Amsterdam, The Netherlands, June 1990.* Order Number DE90706116. Available from NTIS (US Sales Only), PC A04/MF A01; OSTI; INIS.

Despite the wide acceptance of electrostatic screens in ICRH for the protection of the plasma from the near fields of rf antennas, it has always been considered that low voltages at low frequency have made such screens unnecessary in Alfven wave heating (AWH). Despite this, AWH performs rather poorly as a heating method; the results being confused by a density rise up to 300 % of the target density. It is known that the density increase arises neither from impurity injection nor from a change in recycling. In addition, an extensive range of phenomena have been observed in the plasma scrape-off layer (SOL). During AWH, the SOL density is observed to decrease, the SOL floating potential is perturbed in a way that reflects the Alfven wave spectrum, the antennas charge negatively and draw a large current from the plasma and harmonics have been observed on the edge wave fields. The cause and correlation of these effects with each other and their impression on the bulk plasma response was not known. Experimental results from the TORTUS tokamak have indicated that the density increase might be eliminated by electrostatic screens. In their case, two AWH experiments were performed. In the first, an unshielded OFHC copper loop antenna was excited at a given power and, in the second, the same antenna was excited at the same power after installation of an aluminium, TiN coated, slotted screen. The density increase in the first case was shown to be completely eliminated in the second, although spectroscopic measurements revealed a difference in the plasma O(II) and Cu(I) content for each case. (author) 2 refs., 3 figs.

42184 (LRP–403/90, pp. 29-32) **Dynamic response analysis as a tool for investigating transport mechanisms.** Dudok de Wit, Th. (Centre de Recherches en Physique des Plasmas, Lausanne (Switzerland)); Joye, B.; Lister, J.B.; Moret, J.M. Ecole Polytechnique Federale, Lausanne (Switzerland). Centre de Recherche en Physique des Plasma (CRPP). Jun 1990. (CONF-900602–: 17. European conference on controlled fusion and plasma heating, Amsterdam (Netherlands), 25-29 Jun 1990). In *Papers contributed to the 17th EPS conference on controlled fusion and plasma heating, Amsterdam, The Netherlands, June 1990.* Order Number DE90706116. Available from NTIS (US Sales Only), PC A04/MF A01; OSTI; INIS.

Dynamic response analysis provides an attractive method for studying transport mechanisms in tokamak plasmas. The analysis

of the radial response has already been widely used for heat and particle transport studies. The frequency dependence of the dynamic response, which is often omitted, reveals further properties of the dominant transport mechanisms. Extended measurements of the soft X-ray emission were carried out on the TCA tokamak in order to determine the underlying transport processes. (author) 5 refs., 2 figs.

42185 (LRP–403/90, pp. 33-36) **Particle transport studies on TCA using the dynamic response of the effective mass.** Dudok de Wit, Th. (Centre de Recherches en Physique des Plasmas, Lausanne (Switzerland)); Duval, B.P.; Joye, B.; Lister, J.B. Ecole Polytechnique Federale, Lausanne (Switzerland). Centre de Recherche en Physique des Plasma (CRPP). Jun 1990. (CONF-900602–: 17. European conference on controlled fusion and plasma heating, Amsterdam (Netherlands), 25-29 Jun 1990). In *Papers contributed to the 17th EPS conference on controlled fusion and plasma heating, Amsterdam, The Netherlands, June 1990.* Order Number DE90706116. Available from NTIS (US Sales Only), PC A04/MF A01; OSTI; INIS.

Particle tagging in a tokamak provides an attractive method for studying transport mechanisms. The injection of test particles at the plasma edge and the subsequent measurement of their concentration at the centre can be used to quantify the underlying transport mechanisms. This was done on the TCA tokamak by injecting hydrogen into a deuterium discharge, and simultaneously measuring the temporal evolution of the central effective mass and the edge ionization rate. (author) 6 refs., 2 figs.

42186 (LRP–404/90) **Plasma shape and position control in highly elongated tokamaks.** Hofmann, F. (Centre de Recherches en Physique des Plasmas, Lausanne (Switzerland)); Jardin, S.C. Ecole Polytechnique Federale, Lausanne (Switzerland). Centre de Recherche en Physique des Plasma (CRPP). May 1990. 28p. Order Number DE90631942. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Plasma shape and position control in elongated tokamaks is analyzed, using the TSC code. A new algorithm is presented which allows the shape evolution of a discharge to be entirely preprogrammed. The algorithm computes poloidal field coil voltages as functions of time, using magnetic measurements taken close to the vessel wall. No preprogrammed coil current wave-forms are required. By simulating the startup phase of typical TCV tokamak discharges, it is shown that the actual shape evolution follows the preprogrammed one very precisely. X-points can be specified at arbitrary positions. Active stabilization of the dominant vertical mode is achieved by a conventional PD feedback loop. The optimization of feedback coefficients, the tradeoff between shape accuracy and power dissipation in the poloidal field coils, as well as the computing power requirements for implementing the algorithm in a real experiment are discussed. (author) 17 refs., 9 figs.

42187 (LRP–405/90) **Axisymmetric MHD equilibrium solver with bicubic Hermite elements.** Luetjens, H. (Centre de Recherches en Physique des Plasmas, Lausanne (Switzerland)); Bondeson, A.; Roy, A. Ecole Polytechnique Federale, Lausanne (Switzerland). Centre de Recherche en Physique des Plasma (CRPP). May 1990. 21p. Order Number DE90631979. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

A numerical code solving axisymmetric magnetohydrodynamic equilibria with rectangular bicubic Hermite elements has been developed. Two test cases are used for checking the convergence rate of the solution. The mapping of the equilibrium quantities into flux coordinates for magnetohydrodynamic stability calculation is performed by a method which preserves the convergence properties of the cubic Hermite elements. Convergence studies show the behaviour of the stability results when the equilibrium mesh is varied. (author) 13 refs., 3 tabs.

42188 (NIFS–3) **Period-3 catastrophe and enhanced diffusion in two-dimensional Hamiltonian systems.** Ichikawa, Y.H.; Nomura, Y.; Kamimura, T. National Inst. for Fusion Science, Nagoya (Japan). Jan 1990. 21p. Order Number DE90508074. Available from NTIS (US Sales Only), PC A03/MF A01.

Quantitative analysis of the period-3 catastrophe is developed for the standard map and for the stochastic heating map as illustrative examples of two-dimensional area preserving mappings. Analytic expression of the diffusion coefficient is derived for the stochastic heating, and compared to results of numerical observation. Here, as for the case of the standard map, the multi-periodic accelerator modes give rise to anomalous enhancement of the diffusion rate. (author).

42189 (NIFS–4) **Change of transport at L- and H-mode transition.** Itoh, Sanae-I; Itoh, Kimitaka. National Inst. for Fusion Science, Nagoya (Japan). Jan 1990. 14p. Order Number DE90508075. Available from NTIS (US Sales Only), PC A03/MF A01.

A new refined model of the L-mode and H-mode transition in tokamaks is presented based on the bifurcation of the radial electric field, E_r, near edge. The radial gradient of E_r is newly introduced to explain the sudden change of fluctuations as well as plasma fluxes at the onset of transition. This model predicts that the L-to H-mode transition is associated with the decrease of dE_r/dr causing reduction of particle and energy fluxes at critical gradient. (author).

42190 (NIFS–6) **Stochastic properties of the plasma wave heating map.** Nomura, Y.; Kamimura, T.; Ichikawa, Y.H. National Inst. for Fusion Science, Nagoya (Japan). Feb 1990. 33p. Order Number DE90508077. Available from NTIS (US Sales Only), PC A03/MF A01.

Diffusion coefficient for stochastic ion motion in a lower hybrid wave is derived analytically by use of the characteristic function method. The renormalization calculation is carried out successfully to account for effects of the higher order correlation. Numerical observation of the diffusion process confirms the expectation that the renormalized diffusion coefficient describes correctly the stochastic properties of the systems even in the region of the small stochastic parameter, except where the accelerator modes manifest their influence upon the chaotic orbits. (author).

42191 (NIFS–8) **A model of peaked density profile and inward pinch in tokamaks.** Itoh, Sanae-I. National Inst. for Fusion Science, Nagoya (Japan). Feb 1990. 15p. Order Number DE90508079. Available from NTIS (US Sales Only), PC A03/MF A01.

A model theory of peaked density profile and inward flux of ohmic discharges in tokamak is presented. Anomalous particle fluxes in the presence of radial electric field, E_r, and radial current are consistently solved in stationary state. Viscous damping of differential flow due to E_r balances with particle diffusion, which determines density and E_r structures. In viscous plasma, peaked profile is expected. Reduction of edge neutrals induces further inward flux; Change of E_r with ion viscous damping propagates into center, causing the ion heating as well. (author).

42192 (NIFS–9) **Spatial structure of particle-orbit loss regions in l = 2 helical systems.** Sanuki, H.; Todoroki, J.; Kamimura, T. National Inst. for Fusion Science, Nagoya (Japan). Feb 1990. 25p. Order Number DE90508080. Available from NTIS (US Sales Only), PC A03/MF A01.

Particle orbits and loss regions in both configuration and velocity space are studied on the basis of adiabatic invariants and guiding center drift equations. The boundary of loss region is determined from the condition whether the drift surfaces for both localized particles and transition particles between localized and blocked particles hit the limiter or not. Analytical form of loss region boundary for localized particle with V parallel = 0 is obtained. Effects of ripple modulation and electrostatic potential on particle confinement are also discussed. (author).

42193 (PPPL–2696) **An instrument for measuring the momentum flux from atomic and charged particle jets.** Cohen, S.A.; Zonca, F.; Timberlake, J.; Bennett, T.; Cuthbertson, J.; Langer, W.; Motley, R. Princeton Univ., NJ (USA). Plasma Physics Lab. Jul 1990. 17p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76CH03073. Order Number DE90013620. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

We have developed an instrument to measure the momentum flux from an intense plasma stream for which the standard techniques used for low pressure gases (<10 Torr) at room temperature are unsuitable. This device, a Plasma Momentum Meter,

can measure forces of 10^{-5} – 10^{-3} Newtons with a response time of <50 ms onto surfaces of different materials immersed in dense plasmas ($n > 10^{12}$ cm^{-3}). Such forces are transmitted predominantly by ionic and neutral species, with 10's of eV's of kinetic energy, are accompanied by high heat fluxes, and are pulsed. The momentum flux onto a biasable target plate is transferred via a suspended quartz tube onto a sensitive force transducer, a capacitance-type pressure gauge. This protects the transducer from thermal damage, arcing and sputtering. An absolute force calibration of the PMM to 1% accuracy has been made is described. A flat carbon target has been used in measurements of the momentum flux of He, Ne, Ar, and Kr, plasmas produced in a magnetized linear plasma device. 7 refs., 7 figs.

42194 (PPPL–2698) **Ballistic contributions to heat pulse propagation on TFTR [Tokamak Fusion Test Reactor].** Fredrickson, E.D.; McGuire, K.; Cavallo, A.; Budny, R.; Janos, A.; Monticello, D.; Nagayama, Y.; Park, W.; Taylor, G.; Zarnstorff, M.C. Princeton Univ., NJ (USA). Plasma Physics Lab. Jul 1990. 14p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76CH03073. Order Number DE90014714. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

Measurements on the TFTR tokamak of the electron temperature profile evolution and soft x-ray emissivity on a fast (10 μsec) time scale during a sawtooth crash, show that significant heat is deposited beyond the mixing (or reconnection) radius within 200 μsec following a sawtooth crash. This extended region in which electron heat is redistributed during the sawtooth crash substantially complicates the determination of heat transport properties from the subsequent heat pulse propagation. It is shown that the relaxation of this extended perturbation is consistent with the power balance estimates of the local thermal diffusivity. 19 refs., 6 figs.

42195 (PPPL–2709) **The application of correlation techniques to the angular spectrum of scattered radiation from tokamak plasmas.** Nazikian, R. Princeton Univ., NJ (USA). Plasma Physics Lab. Jul 1990. 15p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76CH03073. Order Number DE90013621. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

In the limit of the first Born approximation for a partially coherent secondary source, consisting of a spatially random plasma illuminated by a coherent plane wave, it is shown that the spectral coherence of the scattered radiation as measured on an arbitrary plane beyond the scatterer conveys information on the three dimensional intensity distribution of the random source. By defining a new two point statistical measure of the random field, closely related to the cross spectral density, we show that the fluctuation amplitude of the random source along the direction of the incident plane wave may by recovered from the measurement of the scattered radiation. The application of cross spectral techniques to fluctuation studies on tokamaks is considered. 7 refs.

42196 (PPPL–2710) **Near-field characterization of hydrogen and helium operation on the TFTR [Tokamak Fusion Test Reactor] diagnostic neutral beam.** Kamperschroer, J.H.; Schilling, G.; Roquemore, A.L. Princeton Univ., NJ (USA). Plasma Physics Lab. Jul 1990. 12p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76CH03073. Order Number DE90014712. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

An Optical Multichannel Analyzer has been used to measure beam divergence and composition. This measurement is usually performed near the center of the neutralizer or beyond the magnet. In the past, these locations suffered difficult beam composition analysis and low light intensity, respectively. It has been determined that the light emission is relatively independent of neutralizer line density in the near field, allowing near-field measurements to overcome both difficulties. At optimum perveance, but under conditions of high gas throughput, the helium 1/e-divergence angle was measured to be 1.5°. Further investigation found that the divergence decreased with gas throughput down to 1.25°. Mimimum divergences for the full-, half-, and third-energy hydrogen components were 1.1°, 1.2°, and 1.4°, respectively. Relative neutral hydrogen particle fluxes available for injection into TFTR are a function of perveance. At maximum perveance, the full-, half-, and third-energy atom fractions were 0.25 ± 0.04, 0.5 ± 0.04, and 0.25 ± 0.05, respectively. 10 refs., 5 figs.

42197 (PPPL–2714) **Measurements of the heating beam deposition profile in TFTR [Tokamak Fusion Test Reactor].** Park, H.K. (Princeton Univ., NJ (USA). Plasma Physics Lab.); Budny, R.; Taylor, G.; Zarnstorff, M.C.; Barnes, C.W. Princeton Univ., NJ (USA). Plasma Physics Lab. Aug 1990. 13p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76CH03073. Order Number DE90014733. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

The calculated heating-beam deposition profile is experimentally verified for a variety of target plasma densities for the first time. The calculation of the heating-beam deposition is found to be consistent with the measurement for the discharges without MHD activity. It is also demonstrated that the radial electron flux is unchanged from the ohmic phase to the initial auxiliary heating phase (≤100 msec).

42198 The magnetic pumping of plasmas with sawtooth waveforms. Borovsky, J.E. (Space Plasma Physics Group, Los Alamos National Laboratory, Los Alamos, NM (USA)); Hansen, P.J. *Physics of Fluids B (USA)*, 2(6): 1114-1127 (Jun 1990).

The pumping of plasmas by sawtooth-waveform magnetic induction variations is studied theoretically and by means of computer simulations. A sawtooth is a cyclic waveform that is characterized by a slow increase in the magnetic induction followed by a rapid drop in the induction. Two types of sawtooth pumping are analyzed, and the types classified as to whether or not the first adiabatic invariants of the plasma particles are conserved during the rapid drops in the magnetic induction. When the invariants are conserved, the sawtooth waveforms are found to be less efficient than square waves for pumping plasmas. When the adiabatic invariants are not conserved, the pumping efficiency is found to be a slight improvement over square waves. Both types of pumping are applied to a hypothetical tokamak plasma and it is concluded that neither type of sawtooth pumping is practical for heating magnetically confined fusion plasmas.

42199 Ion temperature effects on ion charge-state distributions of an electron cyclotron resonant ion source. Whaley, D.R. (Department of Nuclear Engineering, University of Michigan, Ann Arbor, Michigan 48109 (USA)); Getty, W.D. *Physics of Fluids B (USA)*, 2(6): 1195-1203 (Jun 1990).

A method is described for determining ion cyclotron resonance (ICR) heating effects on multiply charged-ion energy distributions using a Monte Carlo fit to experimental time-of-flight spectrometer data. The method is general but is used here specifically to separate the effects of plasma ambipolar potential spread and ion temperature in an electron cyclotron resonance (ECR) heated magnetic mirror ion source (MIMI) [Phys. Fluids **28**, 3116 (1985)]. A steady-state equilibrium model is also developed that models the relevant atomic processes occurring in MIMI plasmas. This model and the Monte Carlo analysis are used to relate the effect of midplane ICR heating on end loss ion charge state distributions to its effect on the confined ion distributions. The model allows for collisional, moderately collisional, and collisionless confinement, specific to each charge state in the distribution. Both experiment and modeling show that increased ion temperature causes a shift to lower-Z ion populations in both the confined and end loss charge-state distributions.

42200 Numerical simulations of perturbed Vlasov equilibria. Demeio, L. (Center for Transport Theory and Mathematical Physics, Virginia Polytechnic Institute and State University, Blacksburg, Virginia 24061 (USA)); Zweifel, P.F. *Physics of Fluids B (USA)*, 2(6): 1252-1255 (Jun 1990). DOE Contract FG05-87ER25033.

In this work, the long-time behavior of the solutions of the Vlasov–Poisson system when starting near a spatially homogeneous equilibrium is analyzed numerically. It is found that the asymptotic state toward which the system evolves is not a Bernstein–Green–Kruskal (BGK) equilibrium, but can rather be described by a superposition of BGK modes. Also, it is shown that the small oscillations at the plasma frequency after saturation in the one-sided bump-on-tail instability are due to beating between the unstable mode and the least stable mode.

42201 Correlations of heat and momentum transport in the TFTR tokamak. Scott, S.D.; Arunasalam, V.; Barnes, C.W.; Bell, M.G.; Bitter, M.; Boivin, R.; Bretz, N.L.; Budny, R.; Bush, C.E.; Cavallo, A. *Physics of Fluids B (USA)*, 2(6): 1300-1305 (Jun 1990). DOE Contract AC02-76CH03073.

Measurements of the toroidal rotation speed $v_\phi(r)$ driven by neutral beam injection in tokamak plasmas and, in particular, *simultaneous* profile measurements of v_ϕ, T_i, T_e, and n_e, have provided new insights into the nature of anomalous transport in tokamaks. Low-recycling plasmas heated with unidirectional neutral beam injection exhibit a strong correlation among the local diffusivities, $\chi_\phi \approx \chi_i > \chi_e$. Recent measurements have confirmed similar behavior in broad-density L-mode plasmas. These results are consistent with the conjecture that electrostatic turbulence is the dominant transport mechanism in the tokamak fusion test reactor tokamak (TFTR) [Phys. Rev. Lett. **58**, 1004 (1987)], and are inconsistent with predictions both from test-particle models of strong magnetic turbulence and from ripple transport. Toroidal rotation speed measurements in peaked-density TFTR "supershots" with partially unbalanced beam injection indicate that momentum transport decreases as the density profile becomes more peaked. In high-temperature, peaked-density plasmas the observed gradient scale length parameter $\eta_i^{tot} \equiv d \ln T_i/d \ln n_e$ correlates reasonably well with predictions of the threshold for exciting ion-temperature-gradient-driven turbulence (ITGDT), as would be expected for plasmas at marginal stability with respect to this strong transport mechanism. In L-mode plasmas where ITGDT is expected to be too weak to enforce marginal stability, η_i^{tot} exceeds this threshold considerably.

42202 Diagnostic applications of transient synchrotron radiation in tokamak plasmas. Fisch, N.J. (Princeton Plasma Physics Laboratory, Princeton University, Princeton, New Jersey 08543 (USA)); Kritz, A.H. *Physics of Fluids B (USA)*, 2(6): 1486-1491 (Jun 1990). DOE Contract AC02-76CH03073 ;FG02-84ER53187.

Transient radiation, resulting from a brief, deliberate perturbation of the velocity distribution of superthermal tokamak electrons, can be more informative than the steady background radiation that is present in the absence of the perturbation. It is possible to define a number of interesting inverse problems that exploit the two-dimensional frequency-time data of the transient radiation signal.

42203 Measurements of the toroidal plasma rotation velocity in TFTR major-radius compression experiments with auxiliary neutral beam heating. Bitter, M. (Plasma Physics Laboratory, Princeton University, Princeton, NJ (USA)); Wong, K.L.; Scott, S.; Hsuan, H.; Grek, B.; Johnson, D.; Tait, G. *Physics of Fluids B (USA)*, 2(7): 1503-1506 (Jul 1990). DOE Contract AC02-76CH03073.

The time history of the central toroidal plasma rotation velocity in Tokamak Fusion Test Reactor (TFTR) experiments [Phys. Rev. Lett. **55**, 2587 (1985)] with auxiliary heating by neutral deuterium beam injection and major-radius compression has been measured from the Doppler shift of the emitted Ti XXI Kα line radiation. The experiments were conducted for neutral beam powers in the range 2.1–3.8 MW and line-averaged densities in the range 1.8–3.0×10^{19} m^{-2}. The observed rotation velocity increase during compression is consistent with theoretical estimates.

42204 Wave propagation in one-dimensional inhomogeneous random media with an application to lower hybrid waves in fusion plasmas. Spigler, R. (Dipartimento di Metodi e Modelli Matematici per le Scienze Applicate, Universita di Padova, via Belzoni 7, 35131 Padova (Italy)); Grossmann, W. *Physics of Fluids B (USA)*, 2(7): 1535-1544 (Jul 1990). DOE Contract AC02-76ER03077 ;FG02-86ER53223.

Wave propagation in a one-dimensional stratified medium, whose physical parameters are subject to random fluctuations, is considered. The complex-valued reflection coefficient obeys, as a function of the slab width L, a stochastic Riccati differential equation, associated with an initial-value problem. Using this fact, solving first the boundary-value problem satisfied by the field on $[0,L]$ is avoided. The reflection coefficient can be computed numerically by a Monte-Carlo-type procedure by the generation of suitable sequences of random numbers aimed at constructing realizations of the stochastic processes that enter the refractive index. An application is made to the propagation of "lower hybrid waves" in thermonuclear (fusion) plasmas for realistic models of the deterministic density profile using available experimental data for the statistics of the random fluctuations. Several functional forms of the density profile are considered, and the relevant physical approximations are discussed. This work generalizes a previous analysis that did not include the inhomogeneous background density profile. Results show that the reflected power is a sensitive function of the form of the density profile.

42205 Linear and nonlinear properties of infernal modes. Charlton, L.A. (Oak Ridge National Laboratory, Oak Ridge, Tennessee 37831 (USA)); Carreras, B.A.; Lynch, V.E. *Physics of Fluids B (USA)*, 2(7): 1574-1583 (Jul 1990). DOE Contract AC05-84OR21400.

Infernal modes are pressure-driven instabilities that can occur in low-shear regions of tokamak plasmas for beta values well below the ballooning stability limit. They may be either resistive or ideal. In this paper, stability regions are determined in the plane of elongation versus triangularity to demonstrate the effects of shaping. Both ellipticity and triangularity are needed for stability. The effects of toroidicity, compressibility, and resistivity are also analyzed. A study of the nonlinear evolution of the mode with resistivity shows that complete flux rearrangement can occur suggesting a mechanism for observed internal disruptions.

42206 Mode–particle resonances during near-tangential neutral beam injection in the Tokamak Fusion Test Reactor. Kaita, R. (Princeton Plasma Physics Laboratory, Princeton, New Jersey 08543 (USA)); White, R.B.; Morris, A.W.; Fredrickson, E.D.; McGuire, K.M.; Medley, S.S.; Murphy, T.J.; Scott, S.D. *Physics of Fluids B (USA)*, 2(7): 1584-1588 (Jul 1990). DOE Contract AC02-76CH03073.

Coherent magnetohydrodynamic modes have been observed previously during neutral beam injection in the PDX tokamak [Phys. Rev. Lett. **50**, 891 (1983)] and they have now been seen in the TFTR tokamak [Phys. Fluids **26**, 2958 (1983)]. Periodic bursts of oscillations were detected with several plasma diagnostics, and Fokker–Planck calculations show that the populations of trapped particles in both tokamaks are sufficient to account for fishbone destabilization if a resonant interaction, between the mode and the beam ions, is assumed. Estimates of mode parameters are in reasonable agreement with the experiments, and they indicate that the fishbone mode may continue to affect the performance of intensely heated tokamaks.

42207 Flux confinement measurements in large field-reversed configuration equilibria. Rej, D.J. (Los Alamos National Laboratory, Los Alamos, New Mexico 87545 (USA)); Barnes, G.A.; Baron, M.H.; Chrien, R.E.; Okada, S.; Siemon, R.E.; Taggart, D.P.; Tuszewski, M.; Webster, R.B.; Wright, B.L. *Physics of Fluids B (USA)*, 2(7): 1706-1708 (Jul 1990).

The poloidal magnetic flux ϕ in large field-reversed configuration plasmas is examined experimentally. A wide range of initial equilibrium conditions, with $1 \leq \phi \leq 8$ mWb, is produced by varying the reverse bias magnetic field strength. The flux confinement time τ_ϕ at first improves with bias, albeit with field-null resistivities an order of magnitude larger than classical. A further increase in bias results in a reduction of τ_ϕ, which is inconsistent with either classical or anomalous diffusion theory. The data suggest the importance of nondiffusive processes such as instabilities or formation dynamics.

42208 Ion temperature measurements on TMX-U using a gridless electrostatic analyzer. Falabella, S. (Lawrence Livermore National Laboratory, Livermore, California 94551 (USA)); Molvik, A.W. *Review of Scientific Instruments (USA)*, 61(7): 1892-1899 (Jul 1990). DOE Contract W-7405-ENG-48.

A small retarding-potential analyzer was used on the Tandem Mirror Experiment-Upgrade (TMX-U) to investigate the radial profiles of ion temperature, density, and plasma potential during ion cyclotron resonance heating (ICRH). The analyzer uses the magnetic field of TMX-U, rather than biased grids, to prevent electrons from reaching the biased ion collector. The probe, the Radial Energy Analyzer (REA), has been inserted into the central-cell plasma at temperatures of 200 eV and densities of 3×10^{12} cm^{-3} without

damage to the probe or major degradation of the plasma. This analyzer measured an increase in ion temperature from 20 to 150 eV with 60 kW of ICRH. The REA measurements agree with other diagnostics on TMX-U. A one-dimensional code was written to investigate the effect of space charge on the flow of ions inside the probe tip. The effect was found to be minimal, in agreement with experimental data.

42209 Focusing x-ray spectrograph for laser fusion studies. Yaakobi, B. (Laboratory for Laser Energetics, University of Rochester, 250 East River Road, Rochester, New York 14623-1299 (USA)); Boehly, T.; Audebert, P. *Review of Scientific Instruments (USA)*, 61(7): 1915-1919 (Jul 1990). DOE Contract FC03-85DP40200.

A modified Rowland-circle x-ray spectrograph for laser fusion experiments is described and analyzed. It can be used either as a high-spectral-resolution device or as a monochromatic imaging device (including a backlighting option). The relative merits in each configuration are discussed in detail, and an actual design is worked out numerically.

42210 Demonstration of reduced source size broadening with a Johann focusing elliptical spectrograph and theory of the second-order source broadening. Hammel, B.A. (Lawrence Livermore National Laboratory, Livermore, California, CA (USA)); Phillion, D.W.; Ruggles, L.E. *Review of Scientific Instruments (USA)*, 61(7): 1920-1925 (Jul 1990). DOE Contract AC04-76DP00789.

A Johann focusing elliptical spectrograph has been developed for the measurement of high-resolution x-ray spectra from a spatially extended source. The instrument was designed for the study of high-density, high-temperature plasmas produced by z-pinch implosion or ion-beam bombardment on pulsed-power accelerators. We have constructed and tested this instrument, and have demonstrated an improvement in resolution over what we obtain with a standard circular detector when viewing an extended source. Analytic results for the second-order source broadening due to a finite source size have been obtained and verified by ray tracing. Also given is a simple parametric equation for the Johann crossover curve in terms of either the ellipse sweep angle λ or the Bragg angle θ_B.

42211 Role of edge electric field and poloidal rotation in the *L-H* transition. Groebner, R.J. (General Atomics, San Diego, California 92138 (USA)); Burrell, K.H.; Seraydarian, R.P. *Physical Review Letters (USA)*, 64(25): 3015-3018 (18 Jun 1990). DOE Contract AC03-89ER51114.

Marked changes in the edge radial electric field E_r and in the edge poloidal rotation velocity v_θ are important signatures of the *L-H* transition in the DIII-D tokamak. Shear exists in E_r and v_θ and increases from the *L* mode to the *H* mode. A comparison of experiment with theory shows that shear in E_r and v_θ is sufficient to suppress edge fluctuations, that ion-orbit loss is large enough to be the source of v_θ, and that E_r and v_θ may play a causal role in the *L-H* transition.

42212 Fluid moment models for Landau damping with application to the ion-temperature-gradient instability. Hammett, G.W. (Plasma Physics Laboratory, Princeton University, Princeton, New Jersey 08543 (USA)); Perkins, F.W. *Physical Review Letters (USA)*, 64(25): 3019-3022 (18 Jun 1990). DOE Contract AC02-76CH03073.

A closed set of fluid moment equations is developed which represents kinetic Landau damping physics and which takes a simple form in wave-number space. The linear-response function corresponds to a three-pole (or four-pole) approximation to the plasma dispersion function *Z*. Alternatively, the response is exact for a distribution function which is close to Maxwellian, but which decreases asymptotically as $1/v^4$ (or $1/v^6$). Among other applications, these equations should be useful for nonlinear studies of turbulence driven by the ion-temperature-gradient or other drift-wave microinstabilities.

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Refer also to citation(s) 40973, 42059, 42149, 42272

42213 (BARC–1500) **BARC studies in cold fusion (April-September 1989).** Iyengar, P.K.; Srinivasan, M. (eds.). Bhabha Atomic Research Centre, Bombay (India). Dec 1989. 150p. Order Number DE90632005. Available from NTIS (US Sales Only), PC A07/MF A01; OSTI; INIS.

The report is a compilation of accounts of investigations of various aspects of cold fusion phenomenon during the period April-September 1989 at the Bhabha Atomic Research Centre, Bombay. The report is divided into three parts, namely, Part A, Part B and Part C. Part A consists of 11 papers covering cold fusion through electrolysis channel, while Part B consists of 4 papers covering cold fusion through the route of deuterium loading in the gas phase. Part C consists 5 papers discussing theoretical aspects of cold fusion phenomenon. Some of the papers in the Part C are published as Journal articles. Results show that: (1) d-d fusion reaction does occur in both electrolytic and deuterium loaded palladium and titanium metal lattices at ambient temperature, (2) neutrons and tritium are produced at the same time, but overall neutron to tritium ratio is very low indicating that tritium is the main end product and cold fusion is 'aneutronic' in nature, (3) neutron emission follows Poisson distribution pattern i.e. neutrons are emitted one at a time, however, 15 to 20 per cent of emitted neutrons are generated in bunches or bursts, (4) cold fusion is essentially a surface phenomenon and (5) for detection of tritium in the products of cold fusion, autoradiography is a reliable technique. (M.G.B.).

42214 (BARC–1500 A1.10) **Cold fusion experiments using a commercial Pd-Ni electrolyser (Paper No. A1).** Krishnan, M.S. (Bhabha Atomic Research Centre, Bombay (India). Heavy Water Div.); Malhotra, S.K.; Gaonkar, D.G.; Srinivasan, M.; Sikka, S.K.; Shyam, A.; Chitra, V.; Iyengar, T.S.; Iyengar, P.K. Bhabha Atomic Research Centre, Bombay (India). Dec 1989. In *BARC studies in cold fusion (April-September 1989)*. Order Number DE90632005. Available from NTIS (US Sales Only), PC A07/MF A01; OSTI; INIS.

Using a diffusion type ultra-pure electrolytic hydrogen generator as an electrolyser of which the outer nickel body and a central nickel pipe serve as coaxial anodes and specially activated palladium-silver alloy membrane tubes serve as cathode, the electrolyte made up of 20 per cent NaOD in D_2O of → 99.75 per cent isotopic purity was electrolysed. A bank of BF_3 counters embedded in paraffin moderator block and a plastic scintillator NE102A were used to monitor the neutron yield during and after electrolysis. A bank of ^3He detectors was used as a neutron monitor of the background. In some electrolysis experiments, a bank of silver cathode GM tubes embedded in a paraffin slab was used to measure the neutron yield. Tritium levels in the D_2O electrolyte were measured by liquid scintillation counting technique. Results show that: (1) tritium production is much more than could be accounted by electrolytic enrichment, (2) tritium generation was much higher than neutron yield, (3) there were neutron bursts during and after electrolysis, and (4) spent palladium electrodes loose their capability to support cold fusion reactions. (M.G.B.). 5 refs., 3 tabs., 3 figs.

42215 (BARC–1500 A10.1-A10.8) **Material balance of tritium in electrolysis of heavy water (Paper No. A10).** Malhotra, S.K. (Bhabha Atomic Research Centre, Bombay (India). Heavy Water Div.); Krishnan, M.S.; Sadhukhan, H.K. Bhabha Atomic Research Centre, Bombay (India). Dec 1989. In *BARC studies in cold fusion (April-September 1989)*. Order Number DE90632005. Available from NTIS (US Sales Only), PC A07/MF A01; OSTI; INIS.

A differential equation is derived to get a complete material balance of tritium escaping in the form of DT gas and also as DTO vapour from the system of electrolytic cell during electrolysis of heavy water. Tritium produced in excess of what is predicted from this equation may be attributed to nuclear fusion reactions. Two cases of different operational conditions are considered for application of the derived equation. They are: (1) diffusion type electrolyser with automatic level maintainer, and (2) batch electrolysers of non-diffusion type. (M.G.B.). 6 refs., 1 tab., 3 figs.

42216 (BARC–1500 A11.1-A11.5) **Technique for concentration of helium in electrolytic gases for cold fusion studies (Paper No. A11).** Annaji Rao, K. (Bhabha Atomic Research Centre, Bombay (India). Chemistry Div.). Bhabha Atomic Research Centre, Bombay (India). Dec 1989. In *BARC studies in cold fusion*

(April-September 1989). Order Number DE90632005. Available from NTIS (US Sales Only), PC A07/MF A01; OSTI; INIS.

Gases generated during electrolysis of 0.1M LiOD in heavy water using platinum/palladium electrodes are detected and quantitatively estimated. D_2 and O_2 generated by electrolysis were recombined in situ using platinum catalyst. This facilitated gas collection over long periods of electrolysis and helium, if generated during electrolysis, is concentrated subsequently to be analysed by gas chromatographic analysis. Helium could not be detected in any of the above electrolysis experiments indicating that in these experiments cold fusion has not taken place via the helium pathway. (M.G.B.). 1 tab., 1 fig.

42217 (BARC–1500 A2.1-A2.5) **Preliminary results of cold fusion studies using a five module high current electrolytic cell (Paper No. A2).** Nayar, M.G. (Bhabha Atomic Research Centre, Bombay (India). Desalination Div.); Mitra, S.K.; Raghunathan, P.; Krishnan, M.S.; Malhotra, S.K.; Gaonkar, D.G.; Sikka, S.K.; Shyam, A.; Chitra, V. Bhabha Atomic Research Centre, Bombay (India). Dec 1989. In *BARC studies in cold fusion (April-September 1989).* Order Number DE90632005. Available from NTIS (US Sales Only), PC A07/MF A01; OSTI; INIS.

A high current modular palladium-nickel electrolytic cell was designed and operated to observe cold fusion reactions. The cathode was made up of palladium (25 per cent)-silver and the anode was made up of porous nickel. Using NaOD in D_2O (20 per cent) as an electrolyte, the electrolyser was operated continuously at a current of 60 to 65 amps and applied voltage of $\approx$ 12.5V. The deuterium and oxygen gases produced were carried out of the cell to a recombination unit consisting of burner and condenser. The resultant heavy water was recycled back to the electrolyser. Measurement of the neutron output and tritium content of the electrolyte during and after electrolysis conclusively showed occurrence of cold fusion reactions. Gross neutron to tritium yield ratio was observed to be $\approx 10^{-9}$ which should be taken as a lower limit, because a considerable quantity of tritium carried away by the gas stream could not recovered and taken into account. (M.G.B.). 2 tabs., 2 figs.

42218 (BARC–1500 A3.1-A3.5) **Observation of cold fusion in a Ti-SS electrolytic cell (Paper No. A3).** Krishnan, M.S. (Bhabha Atomic Research Centre, Bombay (India). Heavy Water Div.); Malhotra, S.K.; Gaonkar, D.G.; Nayar, M.G.; Shyam, A.; Sikka, S.K. Bhabha Atomic Research Centre, Bombay (India). Dec 1989. In *BARC studies in cold fusion (April-September 1989).* Order Number DE90632005. Available from NTIS (US Sales Only), PC A07/MF A01; OSTI; INIS.

Using an electrolytic cell made up of a cylindrical rod of titanium as an anode and a stainless steel outer tube as a cathode, both the electrodes coaxially fixed with PTFE spacers and gaskets, 5 N solution of sodium deuteroxide in heavy water of isotopic purity > 99.8 per cent was electrolysed in a batch mode operation, fresh electrolyte being added to make up the volume when the electrolyte level had decreased considerably. After 5 hours of electrolysis at a current density of $\approx$ 406 MA/cm^2 the cathode attained a dull black coating which was found to contain iron as major component and the electrolytic solution developed a greenish yellow colour due to dissolution of iron. After about 3 hours of operation neutron counts were higher than those of the back-ground. The count levels came down at the end presumably due to fouling of cathode surface by iron deposit. Tritium levels at the end of electrolysis were almost three orders of magnitude higher than that of the stock heavy water. These results indicate occurrence of cold fusion in the Ti-D systems. A neutron to tritium yield ratio was found to be $\approx 10^{-7}$. (M.G.B.). 7 refs., 1 tab., 2 figs.

42219 (BARC–1500 A4.1-A4.14) **Multiplicity distribution of neutron emission in cold fusion experiments (Paper No. A4).** Shyam, A. (Bhabha Atomic Research Centre, Bombay (India). Neutron Physics Div.); Srinivasan, M.; Kulkarni, L.V.; Degwekar, S.B. Bhabha Atomic Research Centre, Bombay (India). Dec 1989. In *BARC studies in cold fusion (April-September 1989).* Order Number DE90632005. Available from NTIS (US Sales Only), PC A07/MF A01; OSTI; INIS.

The multiplicity spectrum of neutron emission was measured in 20 ms time intervals in six cold fusion experiments, three with electrolytically loaded palladium electrodes, two with gas loaded titanium targets and one with background. For measurement a bank of BF_3 counters and a bank of ^3He counters - both embedded in paraffin moderator blocks - were used. Data were collected for several hours. Background counts display strictly Poisson statistics. Cases where excess over background neutron bursts were recorded. The bulk of emitted neutrons followed Poisson distribution, however between 10 per cent to 25 per cent of emitted neutrons appeared to display high neutron multiplicity characteristics. The observed frequency distributions indicate bunched neutronic events superposed over a Poisson background. It was observed that bunched neutron events occur on an average for 100 seconds and per bunch 400-600 neutrons are emitted within a 20 ms interval. Viewing this in the light of the experimentally deduced neutron to tritium branching ratio and consequent number of probable fusion reactions, it is concluded that the bunched neutron emission observed in these experiments is due to lattice cracking and these events are not accompanied by tritium production. (M.G.B.). 9 refs., 9 tabs., 1 fig.

42220 (BARC–1500 A5.1-A5.11) **Search for electrochemically catalysed fusion of deuterons in metal lattice (Paper No. A5).** Radhakrishnan, T.P. (Bhabha Atomic Research Centre, Bombay (India). Analytical Chemistry Div.); Sundaresan, R.; Arunachalam, J.; Sitarama Raju, V.; Kalyanaraman, R.; Gangadharan, S.; Iyengar, P.K. Bhabha Atomic Research Centre, Bombay (India). Dec 1989. In *BARC studies in cold fusion (April-September 1989).* Order Number DE90632005. Available from NTIS (US Sales Only), PC A07/MF A01; OSTI; INIS.

As one of the aspects of cold fusion phenomenon, the behaviour of cathode material in an electrolytic cell with platinum as anode and 0.1 M LiOD in heavy water (99.87 per cent purity) as an electrolyte was studied during electrolysis using: (1) different metals palladium, titanium and nickel titanium alloy as cathodes, (2) different shapes of cathode: cylinder, ring and foil (all of palladium), plate (titanium), triangular piece (nickel-titanium alloy), and (3) different shapes of platinum anode: gauze, disc and foil. Differential ellipsometric studies with Pd-cathode and Pt-anode in one cell and Pt-cathode and -anode in another clearly showed that the temperature rise in Pd-Pt cell is due to absorption, dissolution and interaction of deuterons in palladium lattice. In the above mentioned studies, measurement of neutron activity, capture gammas and enthalpy changes were made. Enthalpy changes were measured with isoperibol solution calorimeter with theromistor bridge. Current pulsing was done in some experiments. Results show that: (1) neutron activity above the background level is generated and in some experiments neutron bursts, (2) tritium activity measured at the conclusion of each experiment was in excess of the blank value, and (3) enthalpy release is in excess of electrolysis heating. These observations can only be understood on the basis of occurrence of cold fusion. It is suggested that lattice relaxation subsequent to excitation of Pd-metal lattice to a higher energy level may be the cause of excess enthalpy. (M.G.B.). 5 refs., 1 tab., 9 figs.

42221 (BARC–1500 A6.1-A6.13) **Tritium generation during electrolysis experiment (Paper No. A6).** Radhakrishnan, T.P. (Bhabha Atomic Research Centre, Bombay (India). Analytical Chemistry Div.); Sunderesan, R.; Gangadharan, S.; Sen, B.K.; Murthy, T.S. Bhabha Atomic Research Centre, Bombay (India). Dec 1989. In *BARC studies in cold fusion (April-September 1989).* Order Number DE90632005. Available from NTIS (US Sales Only), PC A07/MF A01; OSTI; INIS.

Electrolyte made up of 0.1 M LiOD in nuclear grade heavy water was electrolysed in quartz cell with palladium cylinder as cathode and platinum gauze as anode. In one experiment the palladium cathode was cleaned by degreasing, using solvents like acetone and then subjecting it to heat treatment, while in the other experiment the cathode was degassed by heat treatment under vacuum followed by deuterium reduction process and again heat treatment under continuous vacuum. Prolonged electrolysis was carried in both the experiments and pulsing was also done. Samples were drawn from the cell during electrolysis from time to time to measure tritium activity. In the first experiment, it was found that at the end of 75 amp. hrs. on three days of electrolysis, excess tritium

(12500 times the input) was generated, while in the second experiment excess tritium was produced between 218 amp. hrs. and 286.2 amp. hrs. In the second experiment the total tritium activity could not be counted as the cell solution was lost due to explosion. Metallographic examination of the palladium cathode from the exploded cell showed an excessive twinning within the palladium grains with worm-like microstructure which suggests an intensive shock wave impact on the metal. (M.G.B.). 2 tabs., 3 figs.

42222 (BARC–1500 A7.1-A7.12) **Burst neutron emission and tritium generation from palladium cathode electrolytically loaded with deuterium (Paper No. A7).** Venkateswaran, G. (Bhabha Atomic Research Centre, Bombay (India). Chemical Group); Moorthy, P.N.; Venkateswarlu, K.S. Bhabha Atomic Research Centre, Bombay (India). Dec 1989. In *BARC studies in cold fusion (April-September 1989).* Order Number DE90632005. Available from NTIS (US Sales Only), PC A07/MF A01; OSTI; INIS.

Using a palladium ring cathode in the form of a hollow ring surrounded on both sides by platinum gauze anodes, 0.1 mol dm^{-3} LiOD in heavy water (99.86 per cent purity) was electrolysed in a quartz cell with a gas tight nylon cap. Palladium ring was pretreated by vacuum degassing. The cell was run for 32 days at a current density of 60 mA/cm^2. A large burst emission of neutrons (signal/background ratio as high as 2000) was observed. Tritium was found in the electrolyte as well as in the water reformed from the absorbed gas recovered from the cathode. A total of 10^{11} fusion events leading to tritium generation were observed while neutron channel accounted for 10^8 fusion events. This indicates that in cold fusion the tritium channel is favoured over the neutron channel. No significant heat output over Joule heating was observed. (M.G.B.). 5 refs., 1 tab., 3 fig.

42223 (BARC–1500 A8.1-A8.12) **Verification studies on electrochemically induced fusion of deuterons in palladium cathodes (Paper No. A8).** Bose, H. (Bhabha Atomic Research Centre, Bombay (India). Reactor Operations and Maintenance Group); Prabhu, L.H.; Sankaranarayanan, S.; Shetiya, R.S.; Veeraraghavan, N.; Joshi, P.V.; Murthy, T.S.; Sen, B.K.; Sharma, K.G.B. Bhabha Atomic Research Centre, Bombay (India). Dec 1989. In *BARC studies in cold fusion (April-September 1989).* Order Number DE90632005. Available from NTIS (US Sales Only), PC A07/MF A01; OSTI; INIS.

Electrolysis of 0.1 M LiOD solution in heavy water was carried out for seven weeks in an electrolytical cell consisting of 1x1x1 cm cube of palladium as cathode and platinum wire gauze as anode to measure heat generation, tritium production and neutron emission. At the end of the experiment the amount of deuterium-loading on palladium was measured. Blank experiment with stainless steel as cathode was conducted to electrolyse water. Some hours after the current was changed to pulsing mode in the main experiment, a mild explosion occurred of which reason could not be properly understood. A net tritium excess corresponding to 50 per cent of the total input tritium was observed. In the initial stages of electrolysis a number of neutron bursts lasting for 2 to 55 minutes each were observed, but no burst was observed in spite of increased loading of palladium with deuterium. Assuming D(d,p)T is the only reaction, excess tritium production corresponds to an average fusion rate of $2.3x10^{-18}$ fusions per d-d pair per second, while if D(d,n)^{3}He is assumed to be the only reaction, number of neutrons emitted in bursts correspond to an average fusion rate of 2.2×10^{-21} fusions per pair of d-d pair per second. (M.G.B.). 2 tabs., 3 figs.

42224 (BARC–1500 B1.1-B1.4) **Search for nuclear fusion in gas phase in deuteriding of titanium metal (Paper No. B1).** Raj, P. (Bhabha Atomic Research Centre, Bombay (India). Chemistry Div.); Suryanarayana, P.; Sathyamoorthy, A.; Datta, T. Bhabha Atomic Research Centre, Bombay (India). Dec 1989. In *BARC studies in cold fusion (April-September 1989).* Order Number DE90632005. Available from NTIS (US Sales Only), PC A07/MF A01; OSTI; INIS.

Deuteriding behaviour of titanium metal was studied through gaseous route, in the absorption as well as desorption modes. In some of the experiments deuterium pressure was cycled between high and low values by changing the temperature of the cell housing the sample. Activated metal pieces were contacted with deuterium gas. Most of the experiments were done in desorption mode. Neutron counting set up consisted of an array of 24 ^{3}He counters arranged in a well like geometry. In some of the experiments a count rate as high as 3900/40 secs was observed as against the steady background count rate of 60 counts/40 secs. The neutron emission phase lasted for several hours at times. (M.G.B.). 4 refs., 2 figs.

42225 (BARC–1500 B3.1-B3.4) **Autoradiography of deuterated Ti and Pd targets for spatially resolved detection of tritium produced by cold fusion (Paper No. B3).** Rout, R.K. (Bhabha Atomic Research Centre, Bombay (India). Neutron Physics Div.); Srinivasan, M.; Shyam, A. Bhabha Atomic Research Centre, Bombay (India). Dec 1989. In *BARC studies in cold fusion (April-September 1989).* Order Number DE90632005. Available from NTIS (US Sales Only), PC A07/MF A01; OSTI; INIS.

Titanium and palladium targets of various shapes and sizes were loaded with deuterium gas. Two methods were used for loading. In one, the target was heated by resistance furnace heating in vacuum and then in deuterium gas, while in the second method ohmic heating was used. Tritium activity was detected by: (1) autoradiography of the treated target using X-ray films, (2) characteristic X-ray measurement of titanium, excited by tritium β, and (3) liquid scintillation counting of tritium β. Some autoradiographs showed fogging due to combined effect of tritium betas and characteristic X-rays of the host material, while others showed several spots indicating presence of tritium localized in microstructure. Liquid scintillation counting detected activities from 50 to 1000 Bq in targets as compared to a background of less than 0.2 Bq. (M.G.B.). 5 refs., 1 tab., 6 figs.

42226 (BARC–1500 B4.1-B4.5) **Evidence for production of tritium via cold fusion reactions in deuterium gas loaded in palladium (Paper No. B4).** Krishnan, M.S. (Bhabha Atomic Research Centre, Bombay (India). Heavy Water Div.); Malhotra, S.K.; Gaonkar, D.G.; Nagvenkar, V.B.; Sadhukhan, H.K. Bhabha Atomic Research Centre, Bombay (India). Dec 1989. In *BARC studies in cold fusion (April-September 1989).* Order Number DE90632005. Available from NTIS (US Sales Only), PC A07/MF A01; OSTI; INIS.

Experiments were conducted to observe cold fusion reaction in deuterium gas loaded palladium. Two types of palladium samples were used. One was commercially procured palladium-silver alloy without any surface treatment and the other was palladium black powder prepared from $PdCl_2$. Deuterium absorption by the powder was very fast, but the same was slow in the alloy. The loading procedure was first to heat the sample to 600degC for two hours under vacuum of better than 10^{-5}mm, cooling to room temperature followed by contact with deuterium gas at 1 atm. and finally keeping for equilibration for several hours in atmosphere free of both moisture and oxygen. Samples were then kept in contact with distilled water for a few hours to extract tritium by isotopic exchange into the water. Tritium activity was measured by liquid scintillation counting. Tritium/deuterium ratio was found to be two-three times more in the case of Pd-Ag foils as compared to Pd powder. The ratio is in the range 10^{-12} to 10^{-11} which is more than two orders of magnitude higher than that in the initial deuterium gas used for loading. Autoradiographs of Pd-Ag foils loaded with deuterium showed fogging due to tritium betas. These observations show that deuterium loading of Pd also induces cold fusion in Pd lattice. (M.G.B.). 5 refs., 1 tab., 1 fig.

42227 (BARC–1500 C2.1-C2.2) **Remarks on cold fusion (Paper No. C2).** Dasannacharya, B.A. (Bhabha Atomic Research Centre, Bombay (India). Nuclear Physics Div.); Rao, K.R. Bhabha Atomic Research Centre, Bombay (India). Dec 1989. In *BARC studies in cold fusion (April-September 1989).* Order Number DE90632005. Available from NTIS (US Sales Only), PC A07/MF A01; OSTI; INIS.

In connection with the cold fusion phenomena observed in Pd-D system, it is pointed out that short-lived large energy fluctuations of a small number of particles which also occur in solids has relevance and may also explain the cold fusion phenomena. Probability of such large energy fluctuations increases near certain transitions under the presence of gradients (of pressure, temperature etc.). In all successful cold fusion experiments reported so far, such favourable conditions for fluctuations exist and these fluctuations can impart energies which are 100 to 1000 times kT to

individual deuterium atoms in PdDsub(x) system, particularly when D/Pd ratio > 0.6 and then deuterium behaves like a lattice liquid with fast diffusion. In this condition deuteron which can get energies ≈ 50 eV can approach another deuterium atom to within ≈ .22 A^0 and start a cold fusion reaction whose products will give rise to more nuclear reactions. (M.G.B.).

42228 (BARC–1500 C5.1-C5.3) **Fracture phenomena in crystalline solids: a brief review in the context of 'Cold Fusion' (Paper No. C5).** Kaushik, T.C. (Bhabha Atomic Research Centre, Bombay (India). Neutron Physics Div.); Srinivasan, M.; Shyam, A. Bhabha Atomic Research Centre, Bombay (India). Dec 1989. In *BARC studies in cold fusion (April-September 1989).* Order Number DE90632005. Available from NTIS (US Sales Only), PC A07/MF A01; OSTI; INIS.

One of the theories proposed to explain the cold fusion phenomenon is fracto-fusion according to which cold fusion may be the result of some kind of beam-target interaction of accelerated particles or hot micro plasma formed at certain sites in solids due to fracture. This proposition is based on the past observations of interaction of gases with metals and emissions of charged particles and radiations from cracks or cleaved surfaces of crystalline solids. If these observations are viewed along with phenomena of large cracks which develop in metal hydrides and embrittlement on hydrogenation, cold fusion may not be after all 'cold' as such. A brief survey of studies investigating such mechanisms and their role in cold fusion is presented and an experiment to verify this proposition is suggested. It consists of accelerating a deuterated projectile to a few km/s with the help of an electric gun or railgun and then causing its impact against another similar target. (M.G.B.). 22 refs.

42229 (CONF-900563–15) **Gamma heating measurements with proportional counters.** Chiu, H.; Bennett, E.F.; Micklich, B.J. Argonne National Lab., IL (USA). May 1990. 17p. Sponsored by U.S. DOE Energy Research. DOE Contract W-31109-ENG-38. From 7. symposium on radiation measurements and applications; Ann Arbor, MI (USA); 21-24 May 1990. Order Number DE90013683. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

A new data acquisition technique (the Continuously-varied Bias-voltage Acquisition mode) has been developed and tested for the low-flux broad-energy regime characteristic of existing fusion blanket mock-ups. This method of analysis allows for the acquisition of data spanning several orders of magnitude in energy with a single proportional counter. Utilizing this method, the gamma energy deposition in a mixed neutron and gamma field was measured. 7 refs., 5 figs.

42230 (CONF-900634–3) **Ceramic breeder materials.** Johnson, C.E. Argonne National Lab., IL (USA). [1990]. 10p. Sponsored by U.S. DOE Energy Research. DOE Contract W-31109-ENG-38. From 7. world ceramics congress: ceramics today–tomorrow's ceramics; Montecatini Terme (Italy); 24-30 Jun 1990. Order Number DE90013672. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

The breeding blanket is a key component of the fusion reactor because it directly involves tritium breeding and energy extraction, both of which are critical to development of fusion power. The lithium ceramics continue to show promise as candidate breeder materials. This promise was recognized by the International Thermonuclear Reactor (ITER) design team in its selection of ceramics as the first option for the ITER breeder material. Blanket design studies have indicated properties in the candidate materials data base that need further investigation. Current studies are focusing on tritium release behavior at high burnup, changes in thermophysical properties with burnup, compatibility between the ceramic breeder and beryllium multiplier, and phase changes with burnup. Laboratory and in-reactor tests, some as part of an international collaboration for development of ceramic breeder materials, are underway. 32 refs., 1 fig., 1 tab.

42231 (DOE/ER/52146–T1) **Helium generation in fusion reactor materials: Final report.** Kneff, D.W.; Oliver, B.M. Rockwell International Corp., Canoga Park, CA (USA). Rocketdyne Div. May 1990. 12p. Sponsored by U.S. DOE Energy Research. DOE Contract FG03-87ER52146. Order Number DE90013005. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

The work performed under this giant included an analysis of the multiple-step helium production mechanism discovered in iron following long-term mixed-spectrum reactor exposure, the measurement of a large number of samples irradiated in fast-neutron environments for cross section determinations, the initial mapping of the neutron fluence distribution for a high-fluence T(d,n) irradiation experiment, the initial measurements of helium production in materials irradiated by 10-MeV neutrons, and the initiation of a joint experiment with ANL to measure the spectrum-integrated Be(n,2n) cross section at lower neutron energies. This work is summarized in the present report. The work is ongoing, and this document thus provides a status report rather than final numerical data.

42232 (IAE–4777-6) **Electrodynamic compression of deuterium plasma by a liner.** Gasilov, V.A.; Grigor'ev, S.F.; Zakharov, S.V.; Krukovskij, A.Yu.; Skorovarov, K.V. Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow (USSR). Inst. Atomnoj Ehnergii. 1989. 16p. (In Russian). Order Number DE90632041. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Possibility is analyzed of neutron generation in the experiment when first cascade deuterium plasma is injected into the second cascade, where plasma compression is performed using massive liner. 19 refs.; 7 figs.

42233 (INT–208/P) **Kinetics of muon-catalyzed fusion in deuterium at temperatures in the region of the liquid deuterium temperature.** Gula, A. (Institute of Physics and Nuclear Techniques, Cracow (Poland)); Warszynski, P.; Gula, E. Institute of Physics and Nuclear Techniques, Cracow (Poland). 1986. 12p. (CONF-8609135–: International symposium on muon-catalyzed fusion, Tokyo (Japan), 1-3 Sep 1986). Order Number DE90632021. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Kinetics of muon-catalyzed fusion in deuterium at temperatures near the liquid deuterium temperature is considered with inclusion of hyperfine structure of $d\mu$ and $dd\mu$, back-decay and the main de-excitation modes of the μ-molecular resonance. The possibilities of obtaining the muon-catalyzed fusion parameters from the data at low temperatures are discussed. 16 refs., 3 figs. (author).

42234 (IYaF–89-80) **On plasma neutron generators for materials testing.** Ivanov, A.A.; Ryutov, D.D. AN SSSR, Novosibirsk (USSR). Inst. Yadernoj Fiziki. 1989. 22p. (In Russian). Order Number DE90632044. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The problems connected with the development of specialized 14 MeV neutron generators which could provide conditions for testing materials for thermonuclear reactors at the $5x10^{13}$n/cm^{2}xs (1MW/m^2) flux density and 10^{22}-$3x10^{22}$n/cm^2 fluence, are discussed. The design of a neutron generator on the base of a gas dynamic trap is considered. The parameters of its systems are compared with those of the ITER tokamak as well as characteristics of plasma and accelerating sources. The conclusion is made that plasma neutron generators on the base of open traps have noticeable advantages as compared with the generators of the accelerating type as regards both energy efectiveness and a closer imitation of netron flux geometry. 27 refs.; 2 figs.; 2 tabs.

42235 (JAERI-M–89-215) **Phase IIA and IIB experiments of JAERI/U.S.DOE collaborative program on fusion blanket neutronics: Neutronics experiment on beryllium configuration in a full-coverage blanket geometry.** Oyama, Yukio (ed.) (Japan Atomic Energy Research Inst., Tokai, Ibaraki (Japan). Tokai Research Establishment). Japan Atomic Energy Research Inst., Tokyo (Japan). Dec 1989. 677p. Order Number DE90508029. Available from NTIS (US Sales Only), PC A99/MF A01.

Phase IIA and IIB experiments on fusion blanket neutronics has been performed on a basis of JAERI/USDOE collaborative program. In the Phase II experimental series, a D-T neutron source and a test blanket were contained by a lithium-carbonate enclosure to adjust the incident neutron spectrum to the test blanket so as to simulate that of a fusion reactor. First two series of the Phase II,

IIA and IIB, focused especially on influences of beryllium configurations for neutron multiplying zone to neutronic parameters. Measured parameters were tritium production rate using Li-glass and NE213 scintillators, and Li-metal foil and Lithium-oxide block with liquid scintillation technique; neutron spectrum using NE213 scintillator and proton recoil proportional counter; reaction rate using foil activation technique. These parameters were compared among six different beryllium configurations of the experimental system. Consistency between different techniques for each measured parameter was also tested among different experimental systems and confirmed to be within experimental errors. This report describes, in detail, experimental conditions, assemblies, equipments and neutron source in Part I. The part II compiles all information required for a calculational analysis of this experiment, e.g., dimensions of the target room, target assembly, experimental assembly, their material densities and numerical data of experimental results. This compilation provides benchmark data to test calculation models and computing code systems used for a nuclear design of a fusion reactor. (author).

42236 (JAERI-M–90-001) **Tokamak plasma shape identification with a Legendre-Fourier expansion of the vacuum poloidal flux function in the toroidal coordinates.** Kurihara, Kenichi (Japan Atomic Energy Research Inst., Naka, Ibaraki (Japan). Naka Fusion Research Establishment); Kimura, Toyoaki; Takahashi, Minoru; Kawamata, Youichi; Sakata, Shinya; Akasaka, Hiromi. Japan Atomic Energy Research Inst., Tokyo (Japan). Feb 1990. 49p. (In Japanese). Order Number DE90508031. Available from NTIS (US Sales Only), PC A03/MF A01.

A new method is proposed for identification of the outermost magnetic surface of tokamak plasmas. The method is based on the analytical solution of the Grad-Shafranov equation in a vacuum region under the toroidal coordinates. This method is applicable to accurate feedback control and real-time visualization of various plasma configurations, and robust to the loss of sensors or the existence of signal noise. (author).

42237 (JAERI-M–90-028) **Joint operation of TSTA under the collaboration between JAERI and DOE-LANL: An integrated loop operation with 100-g tritium in July 1988.** Okuno, Kenji (Japan Atomic Energy Research Inst., Naka, Ibaraki (Japan). Naka Fusion Research Establishment); Enoeda, Mikio; Ide, Takafumi. Japan Atomic Energy Research Inst., Tokyo (Japan). Feb 1990. 77p. Order Number DE90508064. Available from NTIS (US Sales Only), PC A05/MF A01.

Joint operation of the TSTA integrated process loop with 100-g tritium was carried out by JAERI and DOE-LANL in July 1988. One of the major purposes of the present operation was to demonstrate safety of the entire TSTA system for the Technical Safety Appraisal (TSA) conducted by DOE. This joint operation of TSTA was completed successfully and safely. From a technological point of view, the present operation produced many highlights. In particular, it is noteworthy that preliminary data were obtained as to impurity effects of He on performance of the ISS system by injecting 1 and 3 % He with H_2 into the process loop flow. (author).

42238 (JAERI-M–90-038) **Mechanical disturbances in superconducting magnets: Stress analysis.** Sugimoto, Makoto (Japan Atomic Energy Research Inst., Naka, Ibaraki (Japan). Naka Fusion Research Establishment). Japan Atomic Energy Research Inst., Tokyo (Japan). Mar 1990. 54p. (In Japanese). Order Number DE90508067. Available from NTIS (US Sales Only), PC A04/MF A01.

The stress distribution in a small epoxy-impregnated Nb_3Sn coil was calculated by the finite element method. Mechanical disturbances due to the electromagnetic force in the magnet are discussed. The coil stability in relation with the stress distribution is also discussed by using the experimental results. To evaluate such stresses, a calculation model was investigated. It was found that the model, which removed the internal bore element in the model magnet, gave a reasonable condition to estimate to stress. A quench mechanism due to mechanical disturbances in superconducting magnets is discussed. According to this mechanism, an internal slit was assumed as the reason for the mechanical disturbance. The internal slit is generated at the boundary between the superconductor and the bore element by the thermally induced stress. When charging a magnet, the induced electromagnetic force results in a stress concentration at the slit, and hence to an enlargement of it. During the enlargement of the internal slit, heat is generated at the top of it. Such heat generation from a mechanical disturbance can induce a quench. Through these investigations, the following coil manufacturing method can be proposed to reduce such stresses: the magnet should be manufactured to separate the bore element from the superconductor and this separation technique can reduce the boundary stress during cool-down. Actually, a thin teflon film at the boundary between the superconductor and the bore element can be used as a separator. Another separation technique is a teflon coating on the internal bore element. The separation technique should result in a stable epoxy-impregnated superconducting magnet. (J.P.N.).

42239 (LBL–28529) **Preliminary report on the MBE-4, an experimental multiple-beam induction linear accelerator for heavy ions.** Warwick, A.I.; Gough, D.E.; Meuth, H. Lawrence Berkeley Lab., CA (USA). Nov 1988. 36p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00098. Order Number DE90014180. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

A small-scale experimental accelerator called MBE-4 has been constructed to demonstrate the principle of a current-amplifying induction linac for multiple beams of heavy ions. Four beams of Cs^{1+}, initially at 200 keV and each with a current of 10 mA have been accelerated and amplified to a kinetic energy of 700 keV and currents of 90 mA apiece. Transverse focusing is achieved by means of electrostatic quadrupoles; longitudinally the current is amplified and the beam bunch is held together against the space charge forces by special time-dependent accelerating fields. We report on the methods developed for designing and implementing the accelerating pulses and on measurements of the transverse and longitudinal emittance of the accelerated beams. Current fluctuations and the longitudinal emittance are initially almost zero and increase as acceleration errors are accumulated. We discuss the final longitudinal emittance and the current fluctuations in the experiment in terms of their acceptability for a large heavy-ion-fusion driver. 17 refs., 23 figs., 3 tabs.

42240 (NIFS–1) **Design study of the large helical device.** Iiyoshi, A.; Fujiwara, M.; Motojima, O.; Todoroki, J.; Ohyabu, N.; Yamazaki, K. National Inst. for Fusion Science, Nagoya (Japan). Jan 1990. 34p. Order Number DE90508072. Available from NTIS (US Sales Only), PC A03/MF A01.

The Large Helical Device (LHD) is a Heliotron/torsatron type superconducting helical fusion device, which is scheduled to be constructed by the newly established National Institute for Fusion Science as the major joint-university fusion research project. This report describes the design study of the LHD. Our goal is demonstration of high energy confinement and high β in the helical device, which is a necessary step toward a helical reactor system. (author).

42241 (NIFS–2) **Numerical studies on divertor plasmas in helical systems.** Ueda, Noriaki (Mitsubishi Atomic Power Industries, Inc., Tokyo (Japan)); Itoh, Kimitaka; Itoh, Sanae-I. National Inst. for Fusion Science, Nagoya (Japan). Jan 1990. 31p. Order Number DE90508073. Available from NTIS (US Sales Only), PC A03/MF A01.

Scrape-off layer and divertor plasmas in helical systems are studied by using the two-dimensional (2D) numerical simulation code. Unified Edge Divertor Analysis code (UEDA code) is applied to the straight helical model of torsatron/helical heliotron configurations. 2D profiles of plasma parameter, neutrals and impurities are obtained. Erosion rate and neutral back flow rate to the core plasma are also evaluated. Various shapes of the buffle plate are examined from the view point of the establishment of 'dense-cold divertor plasma' by which we can avoid the damage of the target plate. (author).

42242 (NIFS–7) **Three dimensional studies of helical equilibria and magnetic surface breaking due to the finite beta effect.** Hayashi, Takaya; Sato, Tetsuya; Takei, Akira. National Inst.

for Fusion Science, Nagoya (Japan). Feb 1990. 37p. Order Number DE90508078. Available from NTIS (US Sales Only), PC A03/MF A01.

Three dimensional equilibrium and breaking of magnetic surfaces due to the finite beta effect in a l=2 heliotron/torsatron configuration are studied by using a newly developed three-dimensional equilibrium code. The breaking is significantly suppressed as γ_c (pitch parameter) becomes smaller. An in-ward shift of the plasma by using the vertical field and elliptic (vertical) shaping using the quadrupole field can also suppress the breaking. (author).

42243 (ORNL/FTR–3676) **[Calculation methods of neutron nuclear data for structural materials of fast and fusion reactors]: Foreign trip report, June 19–29, 1990.** Larson, D.C. Oak Ridge National Lab., TN (USA). 12 Jul 1990. 27p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE90014411. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The Research Coordination Meeting was devoted to presentation of papers describing advances in calculational techniques to provide neutron nuclear data for the structural materials. Three working groups then summarized the results in the areas of optical model and level density issues, pre-equilibrium and statistical-multistep issues, and standard codes and parameter input libraries for personal computers. At the third Consultant's Meeting in Vienna, final steps were taken to complete development of a nuclear data library (FENDL-1) suitable for fusion reactor design efforts. Following detailed comparisons of evaluations for several of the most important materials, final choices were made from among competing evaluations for materials to be included in the library. A schedule for completion and testing of the first version of the library was set, and areas of improvement for FENDL-2 were discussed.

42244 (PPPL–2702) **Power radiated from ITER and CIT by impurities.** Cummings, J.; Cohen, S.A.; Hulse, R.; Post, D.E.; Redi, M.H.; Perkins, J. Princeton Univ., NJ (USA). Plasma Physics Lab. Jul 1990. 39p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76CH03073. Order Number DE90014715. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

The MIST code has been used to model impurity radiation from the edge and core plasmas in ITER and CIT. A broad range of parameters have been varied, including Z_{eff}, impurity species, impurity transport coefficients, and plasma temperature and density profiles, especially at the edge. For a set of these parameters representative of the baseline ITER ignition scenario, it is seen that impurity radiation, which is produced in roughly equal amounts by the edge and core regions, can make a major improvement in divertor operation without compromising core energy confinement. Scalings of impurity radiation with atomic number and machine size are also discussed. 22 refs., 16 figs.

42245 (PPPL–2705) **Deuterium recycling, confinement, and limiter flux in TFTR [Tokamak Fusion Test Reactor].** Budny, R.V.; Heifetz, D.B. Princeton Univ., NJ (USA). Plasma Physics Lab. Jul 1990. 16p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76CH03073. Order Number DE90014713. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

The neutrals code DEGAS and the transport code SNAP were used to model recycling during steady state phases of Ohmic and neutral beam-heated discharges in TFTR. The flux of deuterium from the inner limiter is calculated to be 15–45 times the total D_α emission rate, with ≈2/3 of the deuterium flux resulting from D^+ flow in the scrape off to the limiter, and ≈1/3 resulting from D^0 scattering off the limiter. The total D^+ ionization rate in the core plasma is 6–24 times the total D_α emission rate, and is larger than the total neutral beam fueling rate. The D_α emission rate, limiter flux, and core ionization rates scale approximately as the square of the volume averaged electron density. 12 refs., 7 figs.

42246 (SAND–89-1538) **An analysis of data from a test of PBFA-2 [Particle Beam Fusion Accelerator-2] plasma opening switch geometries on Blackjack 5.** Renk, T.J. Sandia National Labs., Albuquerque, NM (USA). Mar 1990. 59p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. Order Number DE90013642. Available from NTIS, PC A04/MF A01 - OSTI; GPO Dep.

The Plasma Opening Switch (POS) designed for use on PBFA-2 was operated on the Blackjack 5 generator at Maxwell Laboratories in early 1988. Various switch configurations were tested, with the overall goal of understanding the point at which the switch begins to open, and improving uniformity of opening. Improved load current rate-or-rise and current transfer into high impedance loads were also goals. A baseline-design POS appears to have produced results similar to those seen in an earlier test series of this hardware on Blackjack 5 in 1986. Addition of a second-stage opening switch yielded improvements in the areas mentioned above. Analysis of current signals indicates that switch opening in all geometries was characterized by significant power flow asymmetry downstream of the POS. This report is an analysis of data from this test series.

42247 (SAND–90-1841C) **SNL program overview.** Cook, D.L. Sandia National Labs:, Albuquerque, NM (USA). [1990]. 7p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. (CONF-9001106–1: 1990 JOWOG - 37 meeting, Albuquerque, NM (USA), 22-25 Jan 1990). Order Number DE90014327. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Advances in ion beam theory, diagnostics, and experiments in the past two years have enabled efficient generation of intense proton beams on PBFA II, and focusing of the beam power to 5.4 TW/cm^2, averaged over a 6-mm-diameter target. Target experiments have been started with proton beams, since the range of 4–5 MeV protons is equivalent to 30 MeV lithium. Range-thick conical targets have been used for development of target diagnostics and beam uniformity measurements. Seeded foams have been used to diagnose ion deposition. In order to increase the power density for target experiments, we are now concentrating on development of high voltage lithium ion beams. 2 refs., 6 figs.

42248 Beryllium—a better tokamak plasma-facing material?. Wilson, K.L. (Sandia National Laboratories, Livermore, CA (USA)); Causey, R.A.; Hsu, W.L.; Mills, B.E.; Smith, M.F.; Whitley, J.B. *Journal of Vacuum Science and Technology, A (Vacuum, Surfaces and Films) (USA),* 8(3): 1750-1759 (May 1990). DOE Contract AC04-76DP00789.

The plasma–material interaction and high heat flux properties of beryllium are reviewed to determine its suitability as a plasma-facing component in magnetic fusion energy reactors. Consideration is given to beryllium's outgassing, erosion, and hydrogen retention characteristics. Its responses to normal and off-normal high heat fluxes are compared to graphite in both the as-received and the neutron-irradiated states. Beryllium's performance in present-day devices is assessed, and its expected behavior in future reactors is summarized. It is concluded that beryllium is potentially a better plasma-facing material than graphite and that more development and testing is warranted.

42249 Radiation-enhanced sublimation of graphite in PISCES experiments. Nygren, R.E. (Sandia, Alburquerque, New Mexico 87185 (USA)); Bohdansky, J.; Pospieszczyk, A.; Lehmer, R.; Ra, Y.; Conn, R.W.; Doerner, R.; Hirooka, Y.; Leung, W.K.; Schmitz, L. *Journal of Vacuum Science and Technology, A (Vacuum, Surfaces and Films) (USA),* 8(3): 1778-1782 (May 1990). DOE Contract AS03-84ER52104.

Radiation enhanced sublimation (RES) of graphite leads to potentially high erosion rates in advanced fusion devices (Compact Ignition Tokamak, CIT) and (the International Thermonuclear Experimental Reactor ITER) and may be important in the "carbon blooms" observed in Tokamak Fusion Test Reactor (TFTR) and the Joint European Torus (JET). Erosion rates measured by weight loss are reported for POCO graphite exposed to helium plasmas for a temperature range from 900–2000 °C, ion energies of 30–300 eV, ion fluxes of 1–6×10^{18} cm^{-2} s^{-1}, densities of 2–10×10^{12} cm^{-3}, and electron temperatures of 4–10 eV. These are the first data on RES at fusion-relevant particle fluxes. The data show little reduction from a direct linear dependence upon flux. For these conditions, the amount of redeposition and carbon self-sputtering was minimal. Over 1700 °C, there is evidence of electron emission from the sample.

42250 **A new plasma-surface interactions research facility: PISCES-B and first materials erosion experiments on bulk-boronized graphite.** Hirooka, Y.; Conn, R.W.; Sketchley, T.; Leung, W.K.; Chevalier, G.; Doerner, R.; Elverum, J.; Goebel, D.M.; Gunner, G.; Khandagle, M. *Journal of Vacuum Science and Technology, A (Vacuum, Surfaces and Films) (USA),* 8(3): 1790-1797 (May 1990). DOE Contract AS03-84ER52104.

A new plasma-surface interactions research facility, PISCES-B, has been designed and constructed at the University of California, Los Angeles (UCLA). The entire vacuum chamber is bakable and a base pressure of the order of 10^{-8} Torr is attainable. The PISCES-B facility can generate continuous plasmas of argon, helium, hydrogen, deuterium, and nitrogen. The density of these plasmas ranges from 1×10^{11} to 3×10^{13} cm^{-3} and the electron temperature ranges from 3 to 51 eV. The plasma bombarding flux to the target can be varied from 1×10^{17} to 8×10^{18} ions cm^{-2} s^{-1}. The neutral pressure is controllable in the range from 3×10^{-5} to 1×10^{-3} Torr during plasma operation. An *in situ* surface analysis station with Auger electron spectroscopy (AES), x-ray photoemission spectroscopy (XPS), and secondary ion mass spectroscopy capabilities is attached to the main plasma experimental chamber. Using the PISCES-B facility, first materials erosion experiments have been conducted on newly developed bulk-boronized graphites and selected isotropic graphites for comparison. The erosion yield for 3% boronized graphite due to hydrogen plasma bombardment has been found to be reduced by 30%–40%, relative to isotropic graphites, both in the chemical sputtering and radiation enhanced sublimation regimes at temperatures from 100 to 1300 °C. No significant surface composition change is observed for boronized graphite after plasma bombardment to a total fluence of the order of 10^{22} ions cm^{-2}.

42251 *In situ* **calibration of TFTR neutron detectors.** Hendel, H.W.; Palladino, R.W.; Barnes, C.W.; Diesso, M.; Felt, J.S.; Jassby, D.L.; Johnson, L.C.; Ku, L.; Liu, Q.P.; Motley, R.W. *Review of Scientific Instruments (USA),* 61(7): 1900-1914 (Jul 1990). DOE Contract AC02-76CH03073.

We report results of the TFTR fission detector calibration performed in December 1988. A NBS-traceable, remotely controlled ^{252}Cf neutron source was moved toroidally through the TFTR vacuum vessel. Detection efficiencies for two ^{235}U detectors were measured for 930 locations of the neutron point source in toroidal scans at 16 different major radii and vertical heights. These scans effectively simulated the volume-distributed plasma neutron source and the volume-integrated detection efficiency was found to be insensitive to plasma position. The Campbell mode is useful due to its large overlap with the count rate mode and large dynamic range. The resulting absolute plasma neutron source calibration has an uncertainty of ±13%.

99 GENERAL AND MISCELLANEOUS

42252 (DOE/MA–0396-2) **Listing of awardee names: Inactive awards as of July 5, 1990.** USDOE Assistant Secretary for Management and Administration, Washington, DC (USA). Office of Review and Analysis. [1990]. 394p. Sponsored by U.S. DOE Management & Administration. Order Number DE90013590. Available from NTIS, PC A17/MF A01 - OSTI; GPO Dep.

This document is a computerized listing issued quarterly from the Procurement and Assistance Data System (PADS), including an alphabetical listing of all acquisition and financial assistance award with the Department of Energy. (FSD)

42253 (N–90-19390) **Research reports: 1989 NASA/ASEE Summer faculty fellowship program.** Karr, G.R.; Six, R.; Freeman, L.M. Alabama Univ., Huntsville, AL (USA). Dec 1989. 888p. (NASA-CR–183837;NAS–1.26:183837;CONF-8906334–: 1989 NASA/ASEE summer faculty fellowship program, Huntsville, AL (USA), 5 Jun 1989). Available from NTIS, PC A99/MF E06.

For the twenty-fifth consecutive year, a NASA/ASEE Summer Faculty Fellowship Program was conducted at the Marshall Space Flight Center (MSFC). The basic objectives of the programs are: (1) to further the professional knowledge of qualified engineering and science faculty members; (2) to stimulate an exchange of ideas between participants and NASA; (3) to enrich and refresh the research and teaching activities of the participants' institutions; and (4) to contribute to the research objectives of the NASA Centers. The Faculty Fellows spent ten weeks at MSFC engaged in a research project compatible with their interests and background and worked in collaboration with a NASA/MSFC colleague.

9901 Management

Refer also to citation(s) 40739, 40870, 40947, 41685

422[illegible] (FNAL/C–90/65) **Assuring both quality and creativity in b[illegible]ic research.** Bodnarczuk, M. Fermi National Accelerator Lab., [illegible]tavia, IL (USA). 12 Apr 1990. 9p. Sponsored by U.S. DOE Ener[illegible] Research. DOE Contract AC02-76CH03000. (CONF-9009[illegible]–1: 17. annual conference of the American Society for Quality Control, Tucson, AZ (USA), 9-12 Sep 1990). Order Number DE90011489. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

How does one assure that both quality and creativity are obtained in basic research environments? QA theoreticians have attempted to develop workable definitions of quality, but in more reflective moments, these definitions often fail to capture the deeper essence of the idea of "quality." This paper asserts that creativity (as a product of the human mind) is a concrete interface between perfunctory definitions of quality (conformance to specifications) and more philosophical speculations about the nature of quality- related "ultimates" like elegance or beauty. In addition, we describe the distinction between creative ideas and creative acts and highlight one of the major inhibitors of creativity, fear. Finally we show that highly creative people often have an irreverent attitude toward boundaries and established authority, and discuss how one can allow for this when designing a QA program in a basic research environment.

42255 (IAEA-TECDOC–543) **Procedures for conducting independent peer reviews of probabilistic safety assessment: Guidelines for the International Peer Review Service (IPERS) programme.** International Atomic Energy Agency, Vienna (Austria). Jan 1990. 51p. Order Number DE90634395. Available from NTIS (US Sales Only), PC A04/MF A01; OSTI; INIS.

Independent peer review should be an integral part of any Probabilistic Safety Assessment (PSA). The value of the benefits of a valid PSA may be many times the cost of the study, as demonstrated by a recent report in the United States (EPRI NP-5664) based on utility experience and USNRC perspectives in the practical application of probabilistic risk assesssment (PRA). Independent peer review and revisions, as necessary, give a degree of assurance of validity. The basic disciplines typically covered in a review include event tree analyses, systems analyses, human reliability analyses, data analyses, quantification and uncertainty propagation and external event analyses (if these are included in the PSA). This document is intended to serve as guidelines both for the conduct of an independent peer review of a PSA and for the IPERS programme. The document gives guidance on how an IPER service is conducted, the procedure and steps needed for preparation of an IPER and the technical areas normally covered. 4 tabs.

42256 (ORNL/TM–11537) **Instrumentation and Controls Division maintenance management plan, FY 1990–FY 1992.** Blanton, J.D.; Eads, B.G.; Keller, D.N.; Kunselman, C.W.; Miller, D.R.; Millet, A.J.; Stansberry, C.T.; Wilkerson, P.J. Oak Ridge National Lab., TN (USA). Jun 1990. 36p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE90014700. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This report describes the organization, key functions, and major activities of the Maintenance Management Department. The Department is the key programmatic support element of the Instrumentation and Controls Division. The Department's primary focus is the support of existing equipment and systems at Oak Ridge National Laboratory that are generally characterized as instrumentation and controls. The support takes the form of repair, calibration, fabrication, field engineering, preventive maintenance, software support, and record keeping. 5 refs., 5 figs.

9902 Mathematics and Computers

Refer also to citation(s) 40280, 40281, 40391, 40403, 40425, 40453, 40462, 40463, 40464, 40505, 40566, 40583, 40589, 40600, 40601, 40606, 40608, 40614, 40616, 40649, 40650, 40651, 40704, 40744, 40766, 40773, 40780, 40781, 40782, 40788, 40789, 40791, 40797, 40798, 40799, 40806, 40821, 40828, 40836, 40837, 40865, 40886, 40913, 40917, 40934, 40947, 40974, 41128, 41130, 41241, 41272, 41273, 41274, 41275, 41276, 41278, 41282, 41285, 41290, 41313, 41369, 41372, 41383, 41448, 41453, 41458, 41493, 41497, 41536, 41584, 41586, 41669, 41864, 42012, 42053, 42056, 42058, 42074, 42102, 42130, 42133, 42134, 42315, 42317

42257 (AD-A–219821/6/XAB) **Sensitivity analysis of transputer workfarm topologies. Master's thesis.** Johnson, T.J. Naval Postgraduate School, Monterey, CA (USA). Sep 1989. 79p. Available from NTIS, PC A05/MF A01.

Parallel processing structures such as multiprocessor arrays and pipelining enhance throughput tremendously for suitable algorithms having high degrees of concurrency. However, if the time to process different workpackets becomes irregular, much of the advantage offer traditional sequential processing systems may be lost. In an attempt to produce a more flexible response to workload demands, a transputer workfarm was investigated. Two network topologies, a linear model and a tree model were built using the transputer as the processing element (PE), or worker. An algorithm was developed which could be run independently on all workers in the workfarm. Each worker produced results independent of the other workers. By altering specific variables within the algorithm, the network performance could be changed. The results from this thesis illustrate how these parameters affect each network and provide comparative information between the linear model and the tree model.

42258 (AD-A–219843/0/XAB) **Physics and computation. Doctoral thesis.** Margolus, N.H. Massachusetts Inst. of Tech., Cambridge, MA (USA). Lab. for Computer Science. Mar 1988. 192p. (MIT/LCS/TR–415). Available from NTIS, PC A09/MF A01.

Physics imposes fundamental constraints on the ultimate potentialities of computing mechanisms. The most prominent fundamental constraint coming from physics that is felt today is the finiteness of the speed of light. This constraint implies that communication paths inside of a computer should be as short as possible. For maximum speed, we would also like to have massive parallelism. This motivates us to consider the computational capabilities of cellular automata: uniform arrays of identical processors, each communicating only with nearby neighboring processors.

42259 (AD-A–219849/7/XAB) **Block-LU update for large-scale linear programming. Technical report.** Eldersveld, S.K.; Saunders, M.A. Stanford Univ., CA (USA). Systems Optimization Lab. Jan 1990. 18p. (SOL–90-2). Available from NTIS, PC A03/MF A01.

Stable and efficient updates to the basis matrix factors are vital to the simplex method. The best updating method depends on the machine in use and how the update is implemented. For example, the classical product-form update can take advantage of the vector hardware on current supercomputers, and this helps compensate for its well known drawbacks. Conversely, the method of Bartels and Golub performs well on conventional machines, but is difficult to vectorize. With vectorization in mind, a method is examined based on the block-LU factors of an expanding basis. The partitioned matrix involved was introducted by Bisschop and Meeraus (1977, 1980). The update itself was proposed by Gill, Murray, Saunders and Wright (1984). The main advantages of the bloc-LU update are that it is stable, it vectorizes well, and compared to the product-form update, the nonzeros increase at about two thirds the rate. The update has been incorporated into MINOS and tested on 30 large, sparse linear programming problems. Results are given from runs on the Cray Y-MP.

42260 (AD-A–219850/5/XAB) **Vectorization algorithm for the solution of large, sparse triangular systems of equations. Technical report.** Eldersveld, S.K.; Rinard, M.C. Stanford Univ., CA (USA). Systems Optimization Lab. Jan 1990. 17p. (SOL–90-1). Available from NTIS, PC A03/MF A01.

A new method is given for use with vector computers on applications that require multiple solutions with identically patterned triangular factors and different right-hand sides. A key feature is that a vectorization algorithm is used to place the nonzeros from the factors in a few long vectors. The method is shown to work well when incorporated into the mathematical programming system MINOS and tested on 30 linear programming test problems.

42261 (AD-A–220192/9/XAB) **Determination of algorithm parallelism in NP-complete problems for distributed architectures. Master's thesis.** Beard, R.A. Air Force Inst. of Tech., Wright-Patterson AFB, OH (USA). School of Engineering. Mar 1990. 234p. (AFIT/GCE/ENG–90M-1). Available from NTIS, PC A11/MF A02.

The purpose of this thesis is to explore the methods used to parallelize NP-complete problems and the degree of improvement that can be realized using a distributed parallel processor to solve these combinatoric problems. Common NP-complete problem characteristics such as a priori reductions, use of partial-state information, and inhomogeneous searches are identified and studied. The set covering problem (SCP) is implemented for this research because many applications such as information retrieval, task scheduling, and VLSI expression simplification can be structured as an SCP problem. In addition, its generic NP-complete common characteristics are well documented and a parallel implementation has not been reported. Parallel programming design techniques involve decomposing the problem and developing the parallel algorithms. The major components of a parallel solution are developed in a four phase process. First, a meta-level design is accomplished using an appropriate design language such as UNITY. Then, the UNITY design is transformed into an algorithm and implementation specific to a distributed architecture. Finally, a complexity analysis of the algorithm is performed. the a priori reductions are divided-and-conquer algorithms; whereas, the search for the optimal set cover is accomplished with a branch-and-bound algorithm. The search utilizes a global best cost maintained at a central location for distribution to all processors. Three methods of load balancing are implemented and studied: coarse grain with static allocation of the search space, fine grain with dynamic allocation, and dynamic load balancing.

42262 (AD-A–220250/5/XAB) **Single-assignment language in a distributed-memory multiprocessor. Research report.** Evripidou, P.; Najjar, W.; Gaudiot, J.L. University of Southern California, Marina Del Rey, CA (USA). Information Sciences Inst. Jun 1989. 21p. (ISI/RS–89-249). Available from NTIS, PC A03/MF A01.

Pub. in Proceedings of PARLE '89: Parallel Architectures and Languages Europe, Volume 2: Parallel Languages, (Jun 1989).

Large-scale distributed memory multiprocessors have become commercially available and have proved to be a low-cost alternative to supercomputers for many scientific computations. However, the programming and debugging of such systems remains a difficult and tedious task. Single-assignment and applicative languages have proved to be a serious alternative to imperative languages for the programming of parallel computer systems. They offer the advantage of a high level of programmability and eliminate the problem of detecting parallelism. Their functional property allows an asynchronous parallel execution that does not compromise the correctness of the computation. This paper describes the implementation of a single-assignment language, SISAL, on a distributed memory multiprocessor.

42263 (AD-A–220302/4/XAB) **Experimental high speed/power ratio ASIC designs using residue numbers. Technical report, October 1985-September 1987.** Simoneau, A.; Pizarro, J.; Parker, A. Aerospace Corp., El Segundo, CA (USA). Computer Science Lab. 15 Mar 1990. 32p. (TR–0086(6920-03)-2). Available from NTIS, PC A03/MF A01.

Residue numbers have traditionally been popular for signal processing applications and have recently received renewed interest, for a number of reasons. The inherent parallelism of the residue number system enables the throughput of a system to be increased while keeping the cost reasonable. With the advent of VLSI circuits, the increased size and complexity of parallel residue number circuits may no longer be prohibitive. A method for implementing onboard signal processing algorithms using CMOS Application Specific Integrated Circuits (ASIC) is presented in this

report. This method uses residue arithmetic in a one-out-of-n representation. The representation and implementation methods provide low-power circuits that retain their high-performance capabilities. Details of the adder and multiplier circuits are given, along with an overview of the input/output conversion logic. A specific example algorithm that performs a matrix multiplication has been chosen and implemented. Test chips of the adder demonstrate that the add function performs within our design constraints. Test chips of the algorithm for a particular residue have demonstrated that the arithmetic portions of the chip functioned as expected. Some preliminary results are included at the end of this report with some caveats regarding the particular implementation that we choose.

42264 (AD-A–220748/8/XAB) **On-chip parallelism of VLSI circuits. Doctoral thesis.** Bailey, M.L. Washington Univ., Seattle, WA (USA). Northwest Lab. for Integrated Systems. Aug 1988. 23p. (NW-LIS–89-08-05). Available from NTIS, PC A03/MF A01.

Simulation is a bottleneck in VLSL circuit design. Not only are there many simulation runs throughout the design cycle, but each run can take hours or days to complete. One often suggested means of speeding up event -driven simulation is to use multiple processors to exploit the natural parallelism present in the circuit, that is to partition the circuit among multiple processors , with each executing the same algorithm on its portion of the circuit. This approach assumes that there is sufficient activity, or circuit parallelism, in the circuit to keep all of the processors busy. The author used two approaches in this work. First she formulated a model for studying circuit parallelism and the potential speedup of parallel logic-level simulation. Using this model she considered the effect of the choice of timing model and synchronization strategy on speedup. She also investigated the effect of circuit size on parallelism. Additionally, she developed a methodology for measuring circuit parallelism, and used it to determine the parallelism if nine circuits using two different simulators. Empirical measurements have also been used to validate portions of the formal model.

42265 (AD-A–220805/6/XAB) **Novel numerical algorithms for sensing, discrimination, and control. Final report.** Andrews, M. Space Tech Corp., Fort Collins, CO (USA). 9 Mar 1990. 52p. Available from NTIS, PC A04/MF A01.

This report describes research and development of efficient algorithms and computer architectures for certain Strategic Defense Initiative processing tasks. Spin rate, phase retrieval, and superresolution were analyzed. Efficient mappings of pertinent convolution, Hilbert and Wigner-Ville transforms, and an SVD onto a novel parallel/pipelined architecture were established. An ultrafast E/O interface method to high speed electronic circuits is described. The proposed solution is a fast SIMD/MIND machine capable of teraop speeds, combining multiple 4-PE horizontally microprogrammable nodes onto a mesh-connected organization (fiber-optics).

42266 (AD-A–220872/6/XAB) **Testing for the maximum mean in a mixture of normals.** Gray, H.L.; Woodward, W.A.; McCartor, G. Southern Methodist Univ., Dallas, TX (USA). Dept. of Statistics. 1989. 20p. Available from NTIS, PC A03/MF A01.

Pub. in Communications in Statistics, Part A: Theory and Methods, Vol. 18, No. 11, 4011-4027(1989).

We consider the test of the null hypothesis that the largest mean in a mixture of an unknown number of normal components is less than or equal to a given threshold. This test is motivated by the problem of assessing whether the Soviet Union has been operating in compliance with the Nuclear Test Ban Treaty. In our analysis, the number of normal components is determined using Akaike's Information Criterion while the hypothesis test itself is based on asymptotic results given by Behboodian for a mixture of two normal computers. A bootstrap approach is also considered for estimating the standard error of the largest estimated mean. The performance of the tests are examined through the use of simulation.

42267 (AD-A–220882/5/XAB) **Actual complexity of parallel evaluation of low-degree polynomials.** Leach, R.J.; Atogi, O.M.; Stephen, R.R. Howard Univ., Washington, DC (USA). 1990. 12p. Available from NTIS, PC A03/MF A01.

Pub. in Parallel Computing, Vol. 13, 73-83(1990).

We consider several sequential and parallel algorithms for the evaluation of polynomials of low degree, with particular emphasis on those that are used frequently in computer graphics. A complete accounting of computation times for the speedup and efficiency of these algorithms is reported. The results are compared to standard estimates of these quantities for single and multiprocessors using classical complexity theory. A simulator which is configurable to several parallel architectures is used to provide validation of the results obtained.

42268 (BARC–1469) **A report on digital image processing and analysis.** Singh, B. (Bhabha Atomic Research Centre, Bombay (India). Electronics Div.); Alex, J.; Haridasan, G. Bhabha Atomic Research Centre, Bombay (India). 1989. 96p. Order Number DE90634380. Available from NTIS (US Sales Only), PC A05/MF A01; OSTI; INIS.

This report presents developments in software, connected with digital image processing and analysis in the Centre. In image processing, one resorts to either alteration of grey level values so as to enhance features in the image or resorts to transform domain operations for restoration or filtering. Typical transform domain operations like Karhunen-Loeve transforms are statistical in nature and are used for a good registration of images or template - matching. Image analysis procedures segment grey level images into images contained within selectable windows, for the purpose of estimating geometrical features in the image, like area, perimeter, projections etc. In short, in image processing both the input and output are images, whereas in image analyses, the input is an image whereas the output is a set of numbers and graphs. (author). 19 refs.

42269 (CEA-CONF–9989) **Numerical evaluation of cracked pipes under dynamic loadings using a special finite element.** Petit, M.; Jamet, P. CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Dept. d'Etudes Mecaniques et Thermiques. 1989. 6p. (CONF-890855–: 10. international conference on Structural Mechanics in Reactor Technology (SMIRT), Anaheim, CA (USA), 14-18 Aug 1989). Order Number DE90508370. Available from NTIS (US Sales Only), PC A02/MF A01.

In order to apply the leak before break concept to piping systems, the behavior of cracked pipes under dynamic, and especially seismic, loading must be studied. A simple finite element model of a cracked pipe has been developed and implemented in the general purpose computer code CASTEM 2000. This model has been used for the design of dynamic tests to be conducted on shaking tables. The influence of the frequency of excitation was studied. Finally, evaluation of margin, due to plasticity, in comparison with the standard design procedure is made.

42270 (CEA-CONF–9990) **Seismic analysis of sliding structures.** Brochard, D.; Gantenbein, F. CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Dept. d'Etudes Mecaniques et Thermiques. 1989. 6p. (CONF-890855–: 10. international conference on Structural Mechanics in Reactor Technology (SMIRT), Anaheim, CA (USA), 14-18 Aug 1989). Order Number DE90508371. Available from NTIS (US Sales Only), PC A02/MF A01.

To limit the seism effects, structures may be base isolated. A sliding system located between the structure and the support allows differential motion between them. The aim of this paper is the presentation of the method to calculate the response of the structure when the structure is represented by its eigenmodes, and the sliding phenomenon by the Coulomb friction model. Finally, an application to a simple structure shows the influence on the response of the main parameters (friction coefficient, stiffness,...).

42271 (CEA-CONF–9991) **Design rules for piping: experimental validation of flexibility and elastic stress indices for elbows under bending.** Touboul, F.; Ben Jdidia, M.; Acker, D. CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Dept. d'Etudes Mecaniques et Thermiques. 1989. 6p. (CONF-890855–: 10. international conference on Structural Mechanics in Reactor Technology (SMIRT), Anaheim, CA (USA), 14-18 Aug 1989). Order Number DE90508365. Available from NTIS (US Sales Only), PC A02/MF A01.

Design rules for class 1 piping components are based on stress indices (B, C, K) and flexibility factors (k). For elbows, adjacent straight parts and internal pressure inhibit ovalization of the cross-section, so reducing the sub-mentioned indices. Published

theoretical works and experimental results allow for improvement of coded values. End effect may be represented by a suitable function of the elbow angle. The favourable effect of pressure on C_2, for fatigue damage evaluation, can be taken into account.

42272 (CEA-CONF–9992) **ASME and RCC-MR comparison for the prevention of fatigue analysis.** Autrusson, B.; Acker, D. CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Dept. d'Etudes Mecaniques et Thermiques. 1989. 6p. (CONF-890855–: 10. international conference on Structural Mechanics in Reactor Technology (SMIRT), Anaheim, CA (USA), 14-18 Aug 1989). Order Number DE90508366. Available from NTIS (US Sales Only), PC A02/MF A01.

The purpose of this survey is to compare the simplified methods, without reference to the safety factor allowed for the mechanical properties. An application of both codes, RCC-MR and ASME, on the design of the wall mock-up of the NET project is made and also an estimation with an elastoplastic analysis. In the case of fatigue analysis according to ASME in the plastic field, the elastic stress is magnified by a K_e factor derived from stress variation, S_n, disregarding geometrical discontinuities. According to RCC-MR, the elastic maximum strain will magnified by two coefficients accounting for plasticity and variation of Poisson ratio.

42273 (CEA-CONF–9995) **Crucial effect of boundary conditions on the buckling of shells.** Combescure, A. CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Dept. d'Etudes Mecaniques et Thermiques. 1989. 6p. (CONF-890855–: 10. international conference on Structural Mechanics in Reactor Technology (SMIRT), Anaheim, CA (USA), 14-18 Aug 1989). Order Number DE90508369. Available from NTIS (US Sales Only), PC A02/MF A01.

We want to show here that the boundary conditions can have a drastic effect on the prediction of buckling loads and that this influence can even be more drastic that the initial imperfection in some cases. This is a very important feature because the design rules in case of buckling take into account the effect of initial imperfections but do not consider the effect of unknown boundary conditions. We shall first give two examples showing this drastic effect and then develop a methodology to prevent the designer against over estimation of buckling loads due to a non conservative choice of boundary conditions.

42274 (CEA-CONF–9996) **II-Θ Method: a new method for the stability assessment of crack growth.** Suo, X.Z.; Combescure, A. CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Dept. d'Etudes Mecaniques et Thermiques. 1989. 6p. (CONF-890855–: 10. international conference on Structural Mechanics in Reactor Technology (SMIRT), Anaheim, CA (USA), 14-18 Aug 1989). Order Number DE90508398. Available from NTIS (US Sales Only), PC A02/MF A01.

Based on the continuum mechanics model, thereinafter is performed a mathematical formulation for the second derivatives of potential energy with respect to crack length in the framework of linear elasticity, in order to analyse the stability of a cracked system. We employ for this the perturbation domain technique with Lagrange coordinate; this leads to an explicit expression of the second derivatives which is particularly well amenable to the numerical computations. In the final section the second derivative is shown to be equal to a path independent integral termed D-integral.

42275 (CEA-CONF–10002) **Non linear structural seismic analysis through an equivalent linearization method.** Guihot, P.; Brochard, D.; Gibert, R.J. CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Dept. d'Etudes Mecaniques et Thermiques. 1989. 5p. (CONF-890855–: 10. international conference on Structural Mechanics in Reactor Technology (SMIRT), Anaheim, CA (USA), 14-18 Aug 1989). Order Number DE90508373. Available from NTIS (US Sales Only), PC A02/MF A01.

The seismic methods available for non linear behaviour of structures can be divided in two groups: the outright methods and the non linear methods. In the first case a linear calculation is performed and the results are modified in order to take into account the non-linearity. This method is easy to apply but allows only an approximate knowledge of the structure response. The non linear methods needs the response calculation to specific seismic time histories. The high costs of such methods limit their application to approximate method verification. In this context, equivalent linearization methods give an interesting alternative and are more and more used. The linearization method that we proposed is applied to an one degree of freedom oscillator with shock and a random stationary excitation. This method has been applied to weak and strong non linearities to demonstrate its capabilities but also its limits to represent real structures. The method accuracy is verified against Monte-Carlo simulations and the solution to the Fokker-Planck equation. We can note that the procedure can be extended to the analysis of multidegree of freedom and asymmetric systems.

42276 (CEA-CONF–10003) **Seismic behavior of reinforced concrete shear walls.** Wang, F. (CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (FR). Dept. d'Etudes Mecaniques et Thermiques); Gantenbein, F.; Duretz, C.; Dalbera, J. CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Dept. d'Etudes Mecaniques et Thermiques. 1989. 6p. (CONF-890855–: 10. international conference on Structural Mechanics in Reactor Technology (SMIRT), Anaheim, CA (USA), 14-18 Aug 1989). Order Number DE90508403. Available from NTIS (US Sales Only), PC A02/MF A01.

Reinforced concrete shear walls have an important contribution to building stiffness. So, it is necessary to know their behavior under seismic loads. The ultimate behavior study of shear walls subjected to dynamic loadings includes: - a description of the nonlinear global model based on cyclic static tests, - nonlinear time history calculations for various forcing functions. The comparison of linear and nonlinear results shows important margins related to the ductility when the bandwidth of the forcing function is narrow and centred on the wall natural frequency.

42277 (CEA-CONF–10004) **A two-crown finite element technique for the determination of tearing modulus.** Suo, X.Z.; Combescure, A. CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Dept. d'Etudes Mecaniques et Thermiques. 1989. 6p. (CONF-890855–: 10. international conference on Structural Mechanics in Reactor Technology (SMIRT), Anaheim, CA (USA), 14-18 Aug 1989). Order Number DE90508410. Available from NTIS (US Sales Only), PC A02/MF A01.

The importance of approach to the subject of crack instability for the design of structures containing cracks has increased considerably over the last few years. The tearing modulus theory of Paris and co-workers has emerged as one of the leading criterions for stable crack growth and instability, and estimation of T termed Tearing modulus in the theory has since been investigated theoretically as well as experimentally. Analytical methods exist for calculating the tearing modulus of various crack configurations in simple-shaped structures under certain loading conditions. However, for arbitrary structures under general loading, more sophisticated calculation techniques are required. Extending the virtual crack extension method introduced by Hellen and Parks, a new numerical approach for calculating the tearing modulus is presented and put in a form suitable for instability analysis of structures containing one single crack or several interacting cracks. As the calculation of the energy release rate in elasticity by the virtual crack extension method is related to a stiffness derivative to which only a small region around the crack tip has a contribution, the technique described in the paper shows that it would be reasonable to evaluate the tearing modulus, or rather, the second derivative of potential energy with respect to the crack length, by means of two stiffness derivative calculations in two crowns around the crack tip. In particular, when one crown is strictly included in another one, computation is largely curtailed at this point with some saving of computer time, but a very accurate value of tearing modulus is obtained. As an interesting consequence, an another expression of the tearing modulus is carried out. In Section 4: the classical tearing modulus is proved to be precisely equivalent to a line integral which is independent of integration path. Numerical exam

42278 (CEA-CONF–10005) **Structural analysis of reinforced concrete structures under monotonous and cyclic loadings: numerical aspects.** Lepretre, C. (CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (FR). Dept. d'Etudes Mecaniques et Thermiques); Millard, A.; Reynouard, J.M.; Merabet, O.; Nahas, G.

CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Dept. d'Etudes Mecaniques et Thermiques. 1989. 5p. (CONF-890855–: 10. international conference on Structural Mechanics in Reactor Technology (SMIRT), Anaheim, CA (USA), 14-18 Aug 1989). Order Number DE90508405. Available from NTIS (US Sales Only), PC A02/MF A01.

The structural analysis of reinforced concrete structures is usually performed either by means of simplified methods of strength of materials type i.e. global methods, or by means of detailed methods of continuum mechanics type, i.e. local methods. For this second type, some constitutive models are available for concrete and rebars in a certain number of finite element systems. These models are often validated on simple homogeneous tests. Therefore, it is important to appraise the validity of the results when applying them to the analysis of a reinforced concrete structure, in order to be able to make correct predictions of the actual behaviour, under normal and faulty conditions. For this purpose, some tests have been performed at I.N.S.A. de Lyon on reinforced concrete beams, subjected to monotonous and cyclic loadings, in order to generate reference solutions to be compared with the numerical predictions given by two finite element systems: - CASTEM, developed by C.E.A./.D.E.M.T. - ELEFINI, developed by I.N.S.A. de Lyon.

42279 (CEA-CONF–10012) **A special cracked pipe element for leak before break application.** Brochard, J.; Petit, M.; Millard, A. CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Dept. d'Etudes Mecaniques et Thermiques. 1989. 6p. (CONF-890855–: 10. international conference on Structural Mechanics in Reactor Technology (SMIRT), Anaheim, CA (USA), 14-18 Aug 1989). Order Number DE90508409. Available from NTIS (US Sales Only), PC A02/MF A01.

In order to apply the leak before break concept on pipes, characterization of the stability of circumferential cracks, in case of accidental loadings, has to be done. The questions are the following: can the crack growth be initiated, and if yes how large is the growth. The loading can be static or dynamic, and plastification of the material must be taken into account. A simple finite element model has been developed and will be an industrial tool in leak before break applications.

42280 (CONF-900992–2) **An adaptive blocking strategy for matrix factorizations.** Bischof, C.H.; Lacroute, P.G. Argonne National Lab., IL (USA). [1990]. 12p. Sponsored by U.S. DOE Energy Research. DOE Contract W-31109-ENG-38. From CONPAR '90: international conference on parallel processing; Zurich (Switzerland); 10-13 Sep 1990. Order Number DE90011108. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

On most high-performance architectures, data movement is slow compared to floating-point (in particular, vector) performance. On these architectures block algorithms have been successful for matrix computations. By considering a matrix as a collection of submatrices (the so-called blocks) one naturally arrives at algorithms that require little data movement. The optimal blocking strategy, however, depends on the computing environment and on the problem parameters. Current approaches use fixed-width blocking strategies which are not optimal. This paper presents an "adaptive blocking" methodology for determining in a systematic manner an optimal blocking strategy for a uniprocessor machine. We demonstrate this technique on a block QR factorization routine on a uniprocessor. After generating timing models for the high-level kernels of the algorithm we can formulate the optimal blocking strategy in a recurrence relation that we can solve inexpensively with a dynamic programming technique. Experiments on one processor of a CRAY 2 show that in fact the resulting blocking strategy is as good as any fixed-width blocking strategy. So while we do not know the optimum fixed-width blocking strategy unless we re-run the same problem several times, adaptive blocking provides optimum performance in the very first run. 22 refs., 4 figs.

42281 (CONF-8803269–1) **Some parallel algorithms on the four processor Cray X-MP4 supercomputer.** Kincaid, D.R.; Oppe, T.C. Texas Univ., Austin, TX (USA). Center for Numerical Analysis. May 1988. 12p. Sponsored by U.S. DOE Energy Research; National Science Foundation; Sandia National Laboratories. DOE Contract FG05-87ER25048. Grant DCR-8518722. (CNA–220). From Supercomputer applications of sparse matrix algorithms; Santa Cruz, CA (USA); 27-30 Mar 1988. Order Number DE90013972. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Three numerical studies of parallel algorithms on a four processor Cray X-MP4 supercomputer are presented. These numerical experiments involve the following: a parallel version of ITPACKV 2C, a package for solving large sparse linear systems, a parallel version of the conjugate gradient method with line Jacobi preconditioning, and several parallel algorithms for computing the LU-factorization of dense matrices. 27 refs., 4 tabs.

42282 (CONF-8810515–1) **Conference on iterative methods for large linear systems: Final program.** Kincaid, D.R. (comp.). Texas Univ., Austin, TX (USA). Center for Numerical Analysis. Dec 1988. 92p. Sponsored by U.S. DOE Energy Research. DOE Contract FG05-87ER25048. (CNA–229). From Conference on iterative methods for large linear systems; Austin, TX (USA); 19-21 Oct 1988. Order Number DE90013967. Available from NTIS, PC A05/MF A01 - OSTI; GPO Dep.

This conference is dedicated to providing an overview of the state of the art in the use of iterative methods for solving sparse linear systems with an eye to contributions of the past, present and future. The emphasis is on identifying current and future research directions in the mainstream of modern scientific computing. Recently, the use of iterative methods for solving linear systems has experienced a resurgence of activity as scientists attack extremely complicated three-dimensional problems vector and parallel supercomputers. Many research advances in the development of iterative methods for high-speed computers over the past forty years are reviewed, as well as focusing on current research. The conference is organized by David R. Kincaid, Linda J. Hayes, Graham F. Carey and E. Ward Cheney, who are members of the host organization—the Center for Numerical Analysis (CNA) of the The University of Texas at Austin. Support for this conference is provided, in part, by the Office of Naval Research, the Department of Energy, the National Science Foundation, the Air Force Office of Scientific Research, and the University of Texas at Austin.

42283 (CONF-8810515–2) **The search for omega.** Young, D.M. (Texas Univ., Austin, TX (USA). Center for Numerical Analysis); Mai, Tsun-Zee. Texas Univ., Austin, TX (USA). Center for Numerical Analysis. Aug 1988. 17p. Sponsored by U.S. Department of Defense; U.S. DOE Energy Research; National Science Foundation. DOE Contract FG05-87ER25048. Grant DCR-8518722;Grant AFOSR-85-0052. (CNA–223). From Conference on iterative methods for large linear systems; Austin, TX (USA); 19-21 Oct 1988. Order Number DE90013963. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

For the effective use of iterative algorithms for solving large sparse linear systems it is often necessary to select certain iteration parameters. Examples of iteration parameters are the relaxation factor, omega, for the SOR and SSOR methods and the largest and smallest eigenvalues of the matrix for a basic iterative method when Chebyshev acceleration is used to speed up the convergence. For many iterative algorithms the performance is extremely sensitive to the choice of iteration parameters. Moreover, uncertainty as to how to choose iteration parameters has often, in the past, tended to discourage the use of iterative methods, as opposed to direct methods, for certain classes of problems. The purpose of this paper is to review the development of procedures for choosing iteration parameters, with special emphasis on methods applicable to linear systems arising from the numerical solution of partial differential equations. The discussion will include a priori procedures including analytic techniques, spectral methods, and methods based on related differential equations. Automatic, or "adaptive," procedures, wherein the iteration parameters are improved as the computation proceeds, will also be discussed. Some of these procedures have been incorporated into the ITPACK software packages for solving large sparse linear systems. Numerical experiments indicate that the amount of overhead needed to determine satisfactory parameters is usually not excessive. Methods for choosing iteration parameters for nonsymmetric systems will also be considered.

42284 (CONF-8810515–3) **A dual adaptive procedure for the automatic determination of iteration parameters for Chebyshev acceleration.** Mai, Tsun-Zee (Alabama Univ., University, AL (USA). Dept. of Mathematics); Young, D.M. Texas Univ., Austin, TX (USA). Center for Numerical Analysis. Aug 1988. 22p. Sponsored by U.S. Department of Defense; U.S. DOE Energy Research; National Science Foundation. DOE Contract FG05-87ER25048. Grant DCR-8518722;Grant AFOSR-85-0052. (CNA–224). From Conference on iterative methods for large linear systems; Austin, TX (USA); 19-21 Oct 1988. Order Number DE90013965. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Chebyshev acceleration for a symmetrizable basic iterative method $u^{(n+1)} = Gu^{(n)} + k$ requires estimates of the extreme eigenvalues m(G) and M(G) of the iteration matrix G. Adaptive procedures are often used in order to obtain good estimates for m(G) and M(G). Some existing adaptive procedures are able to give an estimate of either m(G) or M(G) but not both on any given iteration. In this paper we present an adaptive procedure which can estimate both M(G) and M(G) at the same time and which has other useful properties. Numerical results are given which show the new procedure usually requires fewer iterations than previous procedures. 7 refs., 3 tabs.

42285 (CONF-9004231–1) **Parallel multilevel methods.** Young, D.M.; Vona, B.R. Texas Univ., Austin, TX (USA). Center for Numerical Analysis. Mar 1990. 43p. Sponsored by U.S. DOE Energy Research; National Science Foundation. DOE Contract FG05-87ER25048. Grant DCR-8518722. (CNA–243). From Conference on iterative methods; Copper Mountain, CO (USA); 1-5 Apr 1990. Order Number DE90013964. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

In this paper we are concerned with iterative methods for solving the linear system Au = b, where A is given square nonsingular N × N matrix and where b is a given vector.

42286 (DOE/ER/25048–2) **A research program in finite element analysis and iterative solution on advanced processors: Progress report, November 1988–June 1990.** Carey, G.F. (Texas Univ., Austin, TX (USA). Dept. of Aerospace Engineering and Engineering Mechanics); Young, D.M. Texas Univ., Austin, TX (USA). Jun 1990. 11p. Sponsored by U.S. DOE Energy Research. DOE Contract FG05-87ER25048. Order Number DE90013958. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The research program is directed towards the solution of large-scale problems associated with finite element and finite difference schemes for partial differential equations. Of particular interest is the use of iterative methods and finite elements on new vector-parallel super-computing architectures. Some of the work concerns theoretical issues related to convergence of the methods and parallel algorithm formulation. We are also developing new methods based on element-by-element bioconjugate gradient ideas and investigating "breakdown" of the methods from a theoretical standpoint. Applications to large-scale engineering and scientific problems form the final component of the research program. For example, we are currently investigating PDE systems that arise in coupled viscous flow and heat transfer as well as multi-component multiphase flows in enhanced oil recovery. The work on parallel algorithms includes both theory and practical simulations with shared and distributed systems.

42287 (DOE/ER/25048–T1) **Recent vectorization and parallelization of ITPACKV.** Kincaid, D.R.; Oppe, T.C. Texas Univ., Austin, TX (USA). Center for Numerical Analysis. 13 Nov 1989. 17p. Sponsored by U.S. DOE Energy Research; National Science Foundation. DOE Contract FG05-87ER25048. Grant CCR-8518722. (CNA–233). Order Number DE90013968. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

A status report is given on recent work on the vectorization and parallelization of the ITPACKV 2C software. This package has been modified for improved performance on vector supercomputers resulting in a new version called ITPACKV 2D that includes wavefront techniques. The main reason for these changes was to obtain improved vector performance of several routines that did not vectorize in the previous version. Results are also presented on initial efforts at modifying this package to produce a parallel ITPACKV suitable for execution on shared-memory parallel computers with relatively small numbers of processors. 12 refs., 3 tabs.

42288 (DOE/ER/25048–T3) **An overview of NSPCG: A nonsymmetric preconditioned conjugate gradient package.** Kincaid, D.R.; Oppe, T.C.; Joubert, W.D. Texas Univ., Austin, TX (USA). Center for Numerical Analysis. Oct 1988. 26p. Sponsored by U.S. DOE Energy Research; National Science Foundation; Sandia National Laboratories. DOE Contract FG05-87ER25048 ;AS05-81ER10954. Grant DCR-8518722;Grant 06-4298. (CNA–228). Order Number DE90013970. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The most recent research-oriented software package developed as part of the ITPACK Project is called "NSPCG" since it contains many nonsymmetric preconditioned conjugate gradient procedures. It is designed to solve large sparse systems of linear algebraic equations by a variety of different interative methods. The coefficient matrix can be passed in one of several different matrix data storage schemes. These sparse data formats allow matrices with a wide range of structures from highly structured ones such as those with all nonzeros along relatively small number of diagonals to completely unstructured sparse matrices. Alternatively, the package allows the user to call the accelerators directly with user-supplied routines for performing certain matrix operations. In this case, one can use the data format from an application program and not be required to copy the matrix into one of the package formats. This is particularly advantageous when memory space is limited. 26 refs.

42289 (DOE/ER/25048–T4) **ITPACKV 2D user's guide.** Kincaid, D.R.; Oppe, T.C.; Young, D.M. Texas Univ., Austin, TX (USA). Center for Numerical Analysis. May 1989. 13p. Sponsored by U.S. DOE Energy Research; National Science Foundation. DOE Contract FG05-87ER25048. Grant DCR-8518722. (CNA–232). Order Number DE90013971. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

ITPACKV 2D is an adaptation for vector computers of the ITPACK 2C software package for solving large sparse linear systems of equations by adaptive accelerated iterative algorithms.

42290 (DOE/ER/25048–T6) **Generalized conjugate gradient and Lanczos methods for the solution of nonsymmetric systems of linear equations.** Joubert, W. Texas Univ., Austin, TX (USA). Center for Numerical Analysis. ©Jan 1990. 188p. Sponsored by U.S. DOE Energy Research; North Atlantic Treaty Organization; National Science Foundation. DOE Contract FG05-87ER25048. Grant DCR-8518722. (CNA–238). Available from University of Texas, Center for Numerical Analysis, Austin, TX 78713.

This dissertation is concerned with techniques for solving systems of linear equations of the form Au = b where A is a large sparse nonsingular matrix. When A is symmetric and positive definite, the conjugate gradient (CG) method is an effective and widely used technique. However, when A is nonsymmetric, the solution of the linear system by iterative methods is considerably more difficult. The purpose of this dissertation is to investigate extensions of the classical CG method to the nonsymmetric case. This study begins with a review of the existing theory as well as particular classes of algorithms. An important result presented here concerns the inherent limitations of generalized CG methods. We show that a major class of generalized CG methods must necessarily be implemented by algorithms which posses long recurrence relations, making them uneconomical in the general case.

42291 (DOE/ER/25048–T7) **The vectorization of ITPACK 2C.** Oppe, T.C. Texas Univ., Austin, TX (USA). Center for Numerical Analysis. 5 May 1989. 25p. Sponsored by U.S. DOE Energy Research; National Science Foundation. DOE Contract FG05-87ER25048. Grant CCR-8518722. (CNA–230). Order Number DE90013966. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

ITPACKV 2D is an adaptation for vector computers of the ITPACK 2C software package for solving large sparse linear systems of equations by adaptive accelerated iterative algorithms. This paper describes the techniques used to vectorize the iterative algorithms in the ITPACK 2C package for the Cyber 205 and Cray X-MP vector computers. The resulting package was named ITPACK 2D. Results of experiments using ITPACK 2C and ITPACKV

2D are given, including a comparison of megaflop rates and timings for two model problems. 21 refs., 7 tabs.

42292 (EUR–12183) **The assessment of low-level contamination from gamma-emitting radionuclides.** Gray, P.W. (Imperial Coll. Reactor Centre Silwood Park, Ascot (UK)). Commission of the European Communities, Luxembourg (Luxembourg). 1989. 132p. Contract FI1D-0019. Available from NTIS (US Sales Only), PC A07/MF A01.

The objective of this research was to evaluate a new analytical technique to improve the radionuclide activity estimate from area measurements of small-area spectral peaks obtained using multichannel spectrometry. These improvements are based on the application of Bayesian peak fitting, a method of peak fitting that allows the information contained in a spectrum to be used more fully than is possible with the method of gross counting currently employed. The study carried out showed that activity estimates and confidence intervals for activity could be more precisely defined, and the time-related costs reduced up to 50% when making activity measurements by the peak-fitting method (for a fixed detection limit) instead of gross counting. Testing of the method under real conditions would be the logical follow-up to the work achieved.

42293 (IYaF–89-4) **Batch job processing under SVM control.** Baglaj, R.E.; Konurbaev, B.T.; Milen'kij, L.A.; Sysoletin, B.L. AN SSSR, Novosibirsk (USSR). Inst. Yadernoj Fiziki. 1989. 15p. (In Russian). Order Number DE90634386. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The structure and operation of the BATCh-system which is a subsystem of batch job processing for the SVM system (system of virtual machines) which is one of the most popular operating systems for ES computers, are described. 6 refs.; 1 fig.

42294 (JAERI-M–90-007) **JAERI Data Input Support System with window/menu: JDISS.** Maemura, Katsumi (Nuclear Energy Data Center, Tokai, Ibaraki (Japan)); Ishiguro, Misako; Tsuchihashi, Keiichiro; Hiratsuka, Atsushi. Japan Atomic Energy Research Inst., Tokyo (Japan). Feb 1990. 130p. (In Japanese). Order Number DE90508033. Available from NTIS (US Sales Only), PC A07/MF A01.

JAERI Data Input Support System (JDISS) for nuclear codes has been developed in order to respond to the requirement for conversational data inputting environment delivered from troublesome data input tasks. JDISS is a general purpose window/menu designing tool which is code-independent and can be used on usual FACOM TSS terminals without multi-window facility. JDISS aims at easy to use based on ergonomic approach: An appropriate input model can be selected depending on user options, and window-menus to be processed can be automatically displayed according to preset data. FACOM Interactive Programming Facility (IPF) is used as internal processing of JDISS. The user who intends to develop interactive input menus for a code can design a menu by inputting the layout he wants, directly on the display. In this report, features of JDISS and outline of applied techniques are described. How to use the JDISS is also shown by representing an example, where JDISS is applied to interactive input menu generation for a reactor core analysis code SRAC. (author).

42295 (JAERI-M–90-045) **BITNET relay system: Outline of the system.** Yamada, Takayuki (Japan Atomic Energy Research Inst., Tokai, Ibaraki (Japan). Tokai Research Establishment); Ootani, Tetsuya; Suzuki, Tadakazu; Shibata, Sadao. Japan Atomic Energy Research Inst., Tokyo (Japan). Mar 1990. 166p. (In Japanese). Order Number DE90508045. Available from NTIS (US Sales Only), PC A08/MF A01.

It is becoming indispensable for researchers to use international computer network for research information exchange, supported by rapid progress of technologies related to computer and communication. At the Computing Center, JAERI, a software system for computer network relays has been developed to join the international computer network, BITNET via FACOM computer system of JAERI. Owing to this software, it has become possible for JAERI personnel to use the BITNET in April, 1989. In this report, the description of the BITNET relay system is presented. (author).

42296 (JINR-E–7-89-238) **ELPHIC-PC: a new version of the Monte-Carlo code for kinematic simulation of heavy ion-induced reactions.** Lewitowicz, M.; Kliczewski, S. Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions. 1989. 9p. Order Number DE90634387. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

A new version of the programme for kinematic simulation of heavy ion-induced reactions is written. This programme uses a combined standard-weighted Monte-Carlo method, and allows one to simulate both inclusive spectra and correlations between fission fragments, recoils and light particles. As a result, the angular, energy and mass distributions of reaction products in the lab. system are obtained. This programme enables one to check the theoretical model assumptions and to plan new experiments. This version of the programme is written for the PC XT/AT personal computers. 9 refs.; 2 figs.

42297 (JINR-R–10-89-436) **Software for the trajectory recognition registered by the multi-particle spectrometer BIS-2.** Ivanchenko, I.M. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Computing Techniques and Automation); Karpenko, N.N.; Kirillov, D.A.; Likhachev, M.F.; Pal'chik, V.V.; Shanidze, R.G. Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Computing Techniques and Automation. 1989. 10p. (In Russian). Order Number DE90634381. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

The recognition programs which form part of the BISON System being used for control of experiments in real time measurements and for mass data processing registered by the multi-particle spectrometer BIS-2 of JINR are discussed. 10 refs.; 1 fig.

42298 (JINR-R–11-89-378) **Analysis of the hidden anharmonic periodicities.** Zlokazov, V.B. Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Computing Techniques and Automation. 1989. 11p. (In Russian). Order Number DE90634388. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Submitted to Comp. Phys. Commun.

A mathematical method for the detection of the hidden anharmonic periodicities is described. The main idea of the method consists in the following. If h(i) is a periodic anharmonic histogram with the period T, i=O...m and m+1=lxL, where L is integer, the modulus of the discrete Fourier transformation of this histogram is a periodic histogram with a period L, and the histogram h(i) can be regarded as a sum of the periodical harmonic histograms with the periods T_1, wich satisfy the following relations $T_l=T$, $T_l=T_{l-1}$ i-i/i. The methods has been implemented in a Fortran-program ERTQU which was applicated to the analysis of the time distributions of the concentration of the radon in the water in a region Kopetdag Peredovoy Razlom, and of the atmospheric pressure, and simulated data. 3 refs.

42299 (JINR-R–11-89-382) **Searching spectrum points of difference initial-boundary value problems with using GAS.** Mazepa, N.E. Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Computing Techniques and Automation. 1989. 12p. (In Russian). Order Number DE90634382. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

A new algorithm for searching spectrum points is proposed. The difference schemes which approximate systems of linear differential equations of hyperbolic type with constant coefficients and in one space dimension are considered. For important class of practicles problems this algorithm reduces the hard spectrum calculation problem to the polynomial equation solution. For complicated analytic manipulations connected with realization of this algorithm the computation algebraic system REDUCE is used. 28 refs.

42300 (JINR-R–11-89-383) **Description of the SPEKTR program.** Mazepa, N.E. Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Computing Techniques and Automation. 1989. 10p. (In Russian). Order Number DE90634389. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

Submitted to Math. Model.

The SPECTR program for calculation of the spectra of difference half-infinitely boundary-value problems is described. The program realizes a new algorithm for calculation of the spectra. For difference schemes which approximate a linear differential equation with

constant coefficients and in one space dimension and written according to a set of points $r+p \leq 5$, $r \leq 3$ the problem of the spectrum calculation is reduced to the polynomial equation solution. The computation of algebraic system REDUCE is used. The action of the program and possibilities of its using for calculating spectrum points for more complicated problems are demonstrated in examples. 10 refs.

42301 (JINR-R–11-89-427) **BSATOM - package of programs for calculating the energy levels and wave functions of helium-like systems taking into account isotope effects.** Abrashkevich, A.G. (Uzhgorodskij Gosudarstvennyj Univ., Uzhgorod (Ukrainian SSR)); Abrashkevich, D.G.; Vinitskij, S.I.; Puzynin, I.V. Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Computing Techniques and Automation. 1989. 21p. (In Russian). Order Number DE90634390. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Description of package BCATOM for calculating the energy levels and wave functions of helium-like systems in the hyperspherical adiabatic approach taking into account the isotopic effects is given. The corresponding Sturm-Liouville problems are approximated by the difference method and the high order accuracy finite element method. The obtained generalized algebraic eigenvalue problems are solved by subspace iteration method. Possibilities of the package are demonstrated by calculating the ground state characteristics of a negative hydrogen ion. 33 refs.; 1 fig.

42302 (KFKI–1989-62/M) **Collection of scientific papers in collaboration with Joint Institute for Nuclear Research, Dubna, USSR and Central Research Institute for Physics, Budapest, Hungary Vol. 6: Algorithms and programs for solution of some probiems in physics.** Zhidkov, E.P. (Joint Inst. for Nuclear Research, Dubna (USSR)); Lobanov, Yu.Yu.; Nemeth, G. Hungarian Academy of Sciences, Budapest (Hungary). Central Research Inst. for Physics. Nov 1989. 266p. Order Number DE90634391. Available from NTIS (US Sales Only), PC A12/MF A01; OSTI; INIS.

Papers of collaboration of JINR, Dubna and CRIP, Budapest, are presented in the field of algorithms and computer programs for solution of physical problems. The topics include computer evaluation and calculation of functional integrals and Pade approximants, occurring in theoretical particle physics, field theory and statistical physics, error estimations for approximate solutions of quasilinear integrodifferential evolution equations, overview of protocol testing, improved random number generation methods and computer simulation methods in molecule physics. Computer codes are also presented. (D.G.).

42303 (LA–11902-MS) **LINTERP: A numerical algorithm for interpolating quadrilateral and hexahedral meshes.** Wilson, T.L. Los Alamos National Lab., NM (USA). Sep 1990. 11p. Sponsored by U.S. Department of Defense. DOE Contract W-7405-ENG-36. Order Number DE90014417. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

A linear interpolation method, suitable for use on quadrilateral and hexahedral grids with logical or irregular mesh connectivity, is presented. LINTERP, a FORTRAN code that implements this method, is also described. 2 refs., 4 figs.

42304 (MLM–3638) **Operational center point formulas.** Silver, G.L. EG and G Mound Applied Technologies, Miamisburg, OH (USA). 25 Jun 1990. 18p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-88DP43495. Order Number DE90013618. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Operational methods are used to derive a variety of new center point formulas for interpolation problems such as arise in experimental designs. Using the operational method, new three-point integration and derivative formulas are also developed. 8 refs.

42305 (ORNL/TM–11491) **Performance of the Intel iPSC/860 hypercube.** Dunigan, T.H. Oak Ridge National Lab., TN (USA). Jun 1990. 20p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE90014697. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The performance of the Intel iPSC/860 hypercube is contrasted with earlier hypercubes from Intel and Ncube. Computation and communication performance for a number of low-level benchmarks are presented for the Intel iPSC/1 hypercube, the Ncube hypercube, the Intel iPSC/2 hypercube, and the new Intel iPSC/860 hypercube. Performance of the concurrent file system of the iPSC/860 hypercube is also reported. 13 refs., 10 figs., 8 tabs.

42306 (ORNL/TM–11512) **Implementation of Valiant's learnability theory using random sets.** Oblow, E.M. Oak Ridge National Lab., TN (USA). Aug 1990. 35p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE90014709. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Valiant's theory of learnability is recast into random set terms and implemented in an efficient computer learning algorithm. A theoretical and empirical analysis is presented which improves the bounds on the number of examples needed to learn such sets. A general purpose algorithm using these bounds is then described. This algorithm is tested on the multiplexor problem analyzed by others as a benchmark for decision tree and genetic algorithms. Results for this problem show that a set-theoretic implementation of Valiant's theory is computationally competitive with these more established methods. Conclusions are drawn about potential further improvements in the efficiency of Valiant's approach.

42307 (ORNL/TM–11563) **On finding supernodes for sparse matrix computations.** Liu, J.W.H. (York Univ., Toronto, ON (Canada). Dept. of Computer Science); Ng, E.; Peyton, B.W. Oak Ridge National Lab., TN (USA). Jun 1990. 15p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE90013626. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

A simple characterization of fundamental supernodes is given in terms of the row subtrees of sparse Cholesky factors in the elimination tree. Using this characterization, we present an efficient algorithm that determines the set of such supernodes in time proportional to the number of nonzeros and equations in the original matrix. Experimental results are included to demonstrate the use of this algorithm in the context of sparse supernodal symbolic factorization. 18 refs., 3 figs., 3 tabs.

42308 (SAND–90-0047C) **PC-based closed-circuit television system.** Christoffersen, D.; Clark, C. Sandia National Labs., Albuquerque, NM (USA). [1990]. 8p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. (CONF-9007106–26: Institute of nuclear materials management conference, Los Angeles, CA (USA), 15-18 Jul 1990). Order Number DE90013366. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The PC-based closed-circuit television (CCTV) system is a low-cost, highly functional alternative to conventional video system equipment. The system provides routing switching, character generation, video presence detection, and solid-state video recording and replay by using four uniquely designed boards that fit into the backplane slots of an IBM PC-XT-compatible personal computer. Each board controls 16 separate channels, and the boards can be daisy-chained together to build larger, more powerful systems. The system can be configured to handle as many as 240 input signals or up to 48 output channels, and uses a redundant video bus loop. The video bus can be tapped into throughout the loop to provide localized routing switching within several buildings, and video termination at multiple locations, such as security operators' stations. This approach reduces cabling costs and allows additional routing switchers to be added easily with little impact on existing equipment. The system is capable of communicating with several control interfaces, and control software is currently in place for communicating via an RS-232 link and the Intel BitBus network. The hardware drivers are Microsoft C modules that can be linked with a user developed control program.

42309 (SAND–90-0589) **A development plan for a massively parallel version of the hydrocode CTH.** Robinson, A.C.; Fang, E.; Holdridge, D.; McGlaun, J.M. Sandia National Labs., Albuquerque, NM (USA). Jul 1990. 20p. Sponsored by U.S. DOE Energy Research. DOE Contract AC04-76DP00789. Order Number DE90014742. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Massively parallel computers and computer networks are beginning to appear as an integral part of the scientific computing workplace. This report documents the goals and the corresponding development plan of the massively parallel project of Departments 1530 and 1420. The main goal of the project is to provide a clear understanding of the issues and difficulties involved in bringing the current production hydrocode CTH to the state of being portable to a number of currently available parallel computing architectures. In the process of this research, various working versions of the code will be produced. 6 refs., 6 figs.

42310 (SAND–90-0754C) **A Nuisance Alarm Data System for evaluation of intrusion detectors.** Ream, W.K. Sandia National Labs., Albuquerque, NM (USA). [1990]. 5p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. (CONF-9007106–29: Institute of nuclear materials management conference, Los Angeles, CA (USA), 15-18 Jul 1990). Order Number DE90013368. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

A Nuisance Alarm Data System (NADS) was developed to gather long- term background alarm data on exterior intrusion detectors as part of their evaluation. Since nuisance alarms play an important part in the selection of intrusion detectors for use at Department of Energy (DOE) facilities, an economical and reliable way to monitor and record there alarms was needed. NADS consists of an IBM Personal Computer and printer along with other commercial units to communicate with detectors, to gather weather data and to record video for assessment. Each alarm, its assessment and the weather conditions occurring at alarm time are placed into a database that is used in the evaluation of the detector. The operating software is written in Turbo Pascal for easy maintenance and modification. A portable system, based on the NADS design, has been built and shipped to other DOE locations to do on-site alarm monitoring. This has been valuable for the comparison of different detectors in the on-site environment and for testing new detectors when the appropriate conditions do not exist or cannot be simulated at the Exterior Intrusion Detection Testbed.

42311 (SAND–90-1681) **Design of Kerberos modifications to FTP and TELNET.** Brown, C.D. Sandia National Labs., Albuquerque, NM (USA). Jul 1990. 17p. Sponsored by U.S. DOE Management & Administration. DOE Contract AC04-76DP00789. Order Number DE90014704. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Kerberos is a network user authentication system that was recently developed at the Massachusetts Institute of Technology (MIT). It has been adopted by Sandia National Laboratories, Albuquerque, for use in the Secure Supercomputing Network (SSN) which is currently under development. FTP and TELNET are two of the most important network applications for the SSN, which is to use the TCP/IP protocol suite. FTP provides capabilities for bulk file transfer between nodes and TELNET provides a remote interactive login capability across the network. This design describes how authentication is currently performed in FTP and TELNET using clear text passwords and proposes a method for modifying them to use Kerberos authentication.

42312 (SOL–90-9) **Least-index resolution of degeneracy in linear complementarity problems with sufficient matrices.** Cottle, R.W.; Chang, Yow-Yieh. Stanford Univ., CA (USA). Systems Optimization Lab. Jun 1990. 14p. Sponsored by U.S. Department of Defense; U.S. DOE Energy Research; National Science Foundation. DOE Contract FG03-87ER25028. Grant DMS-8913089 N00014-89-J-1659. Order Number DE90014406. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This paper deals with the Principal Pivoting Method (PPM) for the Linear Complementarity Problem (LCP). It is shown here that when the matrix M of the LCP (q,M) is (row and column) sufficient, the incorporation of a least-index pivot selection rule in the PPM makes it a finite algorithm even when the LCP is degenerate. 10 refs.

42313 (UCRL–102791) **Sisal on a message passing architecture.** Grit, D.H. Lawrence Livermore National Lab., CA (USA). Jan 1990. 10p. Sponsored by U.S. DOE Energy Research. DOE Contract W-7405-ENG-48. (CONF-900992–1: CONPAR '90: international conference on parallel processing, Zurich (Switzerland), 10-13 Sep 1990). Order Number DE90008786. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Sisal is a strongly typed, general purpose applicative language that supports data types and operations for scientific computation, and has a Pascal-like syntax to minimize learning time and enhance readability. Sisal has several important semantic properties. First, all functions are mathematically sound – there are no side effects. Second, Sisal programs are referentially transparent. Since names are bound to valves and not memory locations, there is no aliasing. Third, the language is single-assignment – a name is assigned a value only once. In general, a Sisal program defines a set of mathematical expressions where names stand for specific values, and computations progress without state. SISAL was developed as a cooperative effect by Lawrence Livermore National Laboratory, Colorado State University, the University of Manchester, and Digital Equipment Corporation. A primary goal of the Sisal project has been the efficient implementation of the language on commercially available computers. Implementations currently exist on several shared memory multiprocessors. This paper describes an effort to port Sisal to a message-passing, distributed memory environment. The basic characteristics of such an architecture are: a set of processing nodes, each of which contains a processing element and some local memory; and an interconnection structure which permits each node to communicate with any other node. Examples of systems which satisfy this definition are the Intel iPSC/2 and a network of SUNs. 5 refs., 6 figs.

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Refer also to citation(s) 40402, 40566, 40794, 40796, 40876, 41451, 41980, 42152

42314 (CONF-9009176–1) **Building a user interface using SQL*Forms and an intermediate table.** James, T.L. (Tennessee Univ., Knoxville, TN (USA)). Oak Ridge National Lab., TN (USA). 13 Jun 1990. 11p. Sponsored by U.S. Department of Defense. DOE Contract AC05-84OR21400. From International ORACLE User Group conference; Anaheim, CA (USA); 24-28 Sep 1990. Order Number DE90012729. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

There is usually a trade-off between flexibility and ease of use when a user interface is designed. This paper discusses a data retrieval interface that does not require end users to be ORACLE SQL*Plus programmers or to understand the structure of the database and offers them a very powerful and flexible access to the database. This interface is the front-end to a decision support system being designed and prototyped at Oak Ridge National Laboratory (ORNL). The interface develops the "where" clause of a SQL select statement for the user based on selections the user makes and stores and then uses those choices to query a target table. Through SQL*Forms screens, reference data tables are used as a source of values from which users choose data or by which user entries are validated. The user's choices are stored in an intermediate table. Then the system builds a query for the target table(s) using an operating system script in which the value and column names in the intermediate table are used to form the "where" clause. The query is executed and data are retrieved. 5 figs.

42315 (CONF-9009176–2) **Providing dynamic sorting and searching capabilities using SQL*Forms.** Loftis, J.P. Oak Ridge National Lab., TN (USA). 12 Jun 1990. 11p. Sponsored by U.S. Department of Defense. DOE Contract AC05-84OR21400. From International ORACLE User Group conference; Anaheim, CA (USA); 24-28 Sep 1990. Order Number DE90012735. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

One goal of developers of software systems is to build an interface that provides the capability of retrieving and displaying data in a variety of ways, depending on the current needs of the user. This paper describes two techniques used for a prototype system under development at Oak Ridge National Laboratory (ORNL) that provide easy interactive capability between the user and the database using ORACLE's SQL*Forms. The first technique demonstrates how to build an ORACLE application that allows users to decide whether they would like a subset of data retrieved to a multirecord display form and, if so, to define the boundaries for the subset.

The second technique allows users to choose how these displayed data will be sorted. Neither of these techniques requires the user to understood SQL or the underlying database structure of table and column names. 3 figs.

42316 (KEK–89-26) **Proceedings of symposium on data acquisition and processing for next generation experiments.** Fujii, H.; Chiba, J.; Watase, Y. (eds.). National Lab. for High Energy Physics, Tsukuba, Ibaraki (Japan). Mar 1990. 231p. (CONF-8903226–: Symposium on data acquisition and processing for next generation experiments, Tsukuba (Japan), 9-10 Mar 1989). Order Number DE90508151. Available from NTIS (US Sales Only), PC A11/MF A01.

This issue is the collection of the papers presented at the title meeting. The 7 of the presented papers are indexed individually. (J.P.N.).

42317 (LBL–28566) **Random sampling from hash files.** Olken, F. (Lawrence Berkeley Lab., CA (USA)); Rotem, D.; Xu, Ping. Lawrence Berkeley Lab., CA (USA). Dec 1989. 30p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00098. (CONF-9005246–1: SIGMOD 1990, Atlantic City, NJ (USA), 23-25 May 1990). Order Number DE90014165. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

In this paper we discuss simple random sampling from hash files on secondary storage. We consider both iterative and batch sampling algorithms from both static and dynamic hashing methods. The static methods considered are open addressing hash files and hash files with separate overflow chains. The dynamic hashing methods considered are Linear Hash files and Extendible Hash files. We give the cost of sampling in terms of the cost of successfully searching a hash file and show how to exploit features of the dynamic hashing methods to improve sampling efficiency. 22 refs., 8 figs., 3 tabs.

42318 (PB–90-215815/XAB) **Defense Energy Information System. Manual.** Carnes, J. Assistant Secretary of Defense (Production and Logistics), Falls Church, VA (USA). Office of Industrial Base Assessment. Feb 1990. 31p. (DOD–5126.46-M). Available from NTIS, PC A03/MF A01.

The Manual provides clear, reliable, timely, accurate, and objective energy information; prescribes instructions for the preparation and submission of energy data to support the Defense Energy Information System (DEIS); and furnishes information regarding the use of the DEIS.

42319 (SAND–90-0592C) **Relational databases with NIAM models bid "so long" to top-down designs.** Eaton, D.S. Sandia National Labs., Albuquerque, NM (USA). [1990]. 10p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. (CONF-9009176–3: International ORACLE User Group conference, Anaheim, CA (USA), 24-28 Sep 1990). Order Number DE90013496. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Relational databases have many advantages over former hierarchical and network systems — the most important advantage is their ease of modification. This leads designers to a new approach, which we at our company are finding very useful in building an information system of corporate-wide shared data. This approach is a phased bottom-up design and application development which is supported by an information modeling method called NIAM (Nijssen's Information Analysis Method). NIAM is not well known in the USA, but is widely used in Europe. An introduction to the NIAM approach and its advantages will be followed by examples of models and their corresponding relational database designs that have been developed in step-wise fashion at our company. Since NIAM algorithms yield tables in fifth normal form, our relational systems are implemented for optimum update capabilities and enforceable referential integrity. 4 refs., 6 figs.

42320 (WHC-MR–0129) **Hanford PeopleCORE system requirements.** McCargar, S.B.; Johnson, C.F. Westinghouse Hanford Co., Richland, WA (USA). May 1990. 345p. Sponsored by U.S. DOE Management & Administration. DOE Contract AC06-87RL10930. Order Number DE90014303. Available from NTIS, PC A15/MF A01 - OSTI; GPO Dep.

The Hanford People Core (HPC) System subject database concept consolidates information about people from diverse automated and nonautomated systems throughout the Hanford site in order to minimize duplication of data storage, data entry and information gathering and to improve consistency. The intent is to provide single point of entry data collection and maintenance so that data may be shared by various Hanford business functions to support a business objective of accurate and time information about people. Specific objectives to be accomplished are: establish a common database of basic information about people associated with the Hanford Site, standardize data element names and definitions, document the HPC data resource in the Site Data Dictionary, support site service organizations directly and by interface to eliminate redundant information entry, provide accurate and timely location information for individuals associated with the Hanford Site to various Hanford Business functions, track distribution information to identify the distribute material to specified individuals and/or companies associated with the Hanford Site, track WHC organizational structure information to establish organization charts and share organization data with other WHC applications, and provide data about WHC people to be shared by various WHC business applications.

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AC04-88DP43495	**EG and G Mound Applied Technologies, Miamisburg, OH (USA)**	
	15:41078	MLM–3641(OP)
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AC04-89AL58309	**Environmental Evaluation Group, Albuquerque, NM (USA)**	
	15:41508	DOE/AL/58309–45
AC05-76OR00033		
	15:40299	CONF-900402–
	15:41098	Published article
AC05-81OR20722	**Argonne National Lab., IL (USA)**	
	15:40459	DOE/OR/20722–193.1-Draft
AC05-84OR21400	**Oak Ridge National Lab., TN (USA)**	
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	15:40401	CONF-9007106–35
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	15:40403	CONF-9009110–2
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	15:40605	ORNL/FTR–3673
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	15:40701	ORNL/FTR–3641
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	15:41254	CONF-9009125–2
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	15:41452	CONF-900563–9
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	15:41613	CONF-9002130–1
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	15:41803	ORNL/FTR–3663
	15:41804	ORNL/FTR–3669
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	15:42305	ORNL/TM–11491
	15:42306	ORNL/TM–11512
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	General Atomics, San Diego, CA (USA)	
	15:42154	GA-A-20057
	Nuclear Regulatory Commission, Washington, DC (USA). Div. of Systems Technology	
	15:40732	NUREG/CR-5374
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	15:42205	Published article
AC05-84OS21400	**Oak Ridge Y-12 Plant, TN (USA)**	
	15:41050	Y/TR-90/4
AC05-84OT21400	**Oak Ridge Gaseous Diffusion Plant, TN (USA)**	
	15:40413	K/WM-5
	15:40788	K/CSD/INF-90/28
	15:41244	K/CSD/INF-89/42
	Martin Marietta Energy Systems, Inc., Oak Ridge, TN (USA)	
	15:40404	CONF-9009178-1
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AC05-84OU21400	**Paducah Gaseous Diffusion Plant, KY (USA)**	
	15:40414	KY/H-104-Rev.1
AC05-86OR21548	**Argonne National Lab., IL (USA)**	
	15:40460	DOE/OR/21548-106
AC06-76RL01830	**Hanford Works, Richland, WA (USA)**	
	15:40762	HAN-45830-Del.
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	Battelle Pacific Northwest Lab., Richland, WA (USA)	
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	General Electric Co., Richland, WA (USA). Hanford Atomic Products Operation	
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	Electric Power Research Inst., Palo Alto, CA (USA)	
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	Pacific Northwest Lab., Richland, WA (USA)	
	15:40422	PNL-6791
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	15:40487	DOE/BP-01830-5
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AC06-81ER40048		
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AC06-87RL10930	**Westinghouse Hanford Co., Richland, WA (USA)**	
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	15:41577	WHC-MR-0165
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AC07-76ID01570	**EG and G Idaho, Inc., Idaho Falls, ID (USA)**	
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AC07-88ID12700	**Nuclear Packaging Corp., Federal Way, WA (USA)**	
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	15:41260	DOE/ID/12700-1-Vol.2-Rev.1
AC07-88ID12701	**B and W Fuel Co., Lynchburg, VA (USA)**	
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AC07-88ID12702	Nuclear Assurance Corp., Norcross, GA (USA)	
	15:41262	DOE/ID/12702–1-Vol.1
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AC08-83NV10282	EG and G Energy Measurements, Inc., Las Vegas, NV (USA). Remote Sensing Lab.	
	15:41592	EGG–10282-1095
AC08-88NV10617	EG and G Energy Measurements, Inc., Albuquerque, NM (USA). Kirtland Operations	
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AC08-90NV10845	Nevada Univ., Las Vegas, NV (USA). Desert Research Inst.	
	15:41590	DOE/NV/10845–01
AC09-76SR00001	Savannah River Lab., Aiken, SC (USA)	
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AC09-89SR18035	Savannah River Lab., Aiken, SC (USA)	
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	15:41005	WSRC-tr–136
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AC12-76SN00052	Knolls Atomic Power Lab., Schenectady, NY (USA)	
	15:41624	KAPL–4714
AC21-85MC22182	Little (Arthur D.), Inc., Cambridge, MA (USA)	
	15:40587	DOE/MC/22182–2824
AC21-86MC23075		
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AC22-84PC60422	TRW Space and Technology Group, Redondo Beach, CA (USA). Applied Technology Div.	
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AC22-86PC90751	PSI Technology Co., Andover, MA (USA)	
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AC22-87PC79661	Catholic Univ. of America, Washington, DC (USA). Dept. of Mechanical Engineering	
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AC22-87PC79680		
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AC22-88PC88814		
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AC79-87BP34673	Engineering Information, Inc., New York, NY (USA)	
	15:40886	DOE/BP/34673–1
AC79-88BP91489	Portland State Univ., OR (USA)	
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AI22-87PC79660	Naval Civil Engineering Lab., Port Hueneme, CA (USA)	
	15:40342	DOE/PC/79660–T4
AI79-83BP39638	USDOE Bonneville Power Administration, Portland, OR (USA). Div. of Fish and Wildlife	
	15:41618	DOE/BP/39638–5
AI79-83BP39645	National Marine Fisheries Service, Seattle, WA (USA). Coastal Zone and Estuarine Studies Div.	
	15:40492	DOE/BP/39645–3
AI79-84BP16726	Forest Service, Corvallis, OR (USA). Pacific Northwest Range and Experiment Station	
	15:41617	DOE/BP/16726–5
AI79-88BP50301	National Marine Fisheries Service, Seattle, WA (USA). Coastal Zone and Estuarine Studies Div.	
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AS03-84ER52104		
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AS05-81ER10954	Texas Univ., Austin, TX (USA). Center for Numerical Analysis	
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AT03-87ER40327		
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BI79-83BP11631	USDOE Bonneville Power Administration, Portland, OR (USA). Div. of Fish and Wildlife	
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BI79-83BP39461	USDOE Bonneville Power Administration, Portland, OR (USA). Div. of Fish and Wildlife	
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BI79-84BP17622	USDOE Bonneville Power Administration, Portland, OR (USA). Div. of Fish and Wildlife	
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BI79-87BP35769	Oregon Dept. of Fish and Wildlife, Portland, OR (USA)	
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BI79-88BP92122	Oregon Dept. of Fish and Wildlife, Corvallis, OR (USA)	
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FC03-85DP40200		
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FC07-88ID12797	Stone and Webster Engineering Corp., Boston, MA (USA)	
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FC21-86MC10637	North Dakota Univ., Grand Forks, ND (USA). Energy and Mineral Research Center	
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FC21-87MC24207	West Virginia Univ., Morgantown, WV (USA). Dept. of Statistics and Computer Science	
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FC21-88MC24167	Energy International, Inc., Pittsburgh, PA (USA)	
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FG02-84ER13183	Wisconsin Univ., Madison, WI (USA). Dept. of Chemical Engineering	
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FG02-84ER40171	Harvard Univ., Cambridge, MA (USA). Dept. of Physics	
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FG02-84ER45142	Minnesota Univ., Minneapolis, MN (USA). School of Physics and Astronomy	
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FG02-84ER53187	**Hunter Coll., New York, NY (USA)**	
	15:42147	CONF-900602–17
	City Univ. of New York, NY (USA)	
	15:42146	CONF-900602–16
	15:42202	Published article
FG02-85ER53198	**Wisconsin Univ., Madison, WI (USA)**	
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FG02-86ER13537	15:40314	CONF-900402–
FG02-86ER13558	15:41140	Published article
FG02-86ER45228	**Arizona State Univ., Tempe, AZ (USA). Dept. of Physics**	
	15:41041	DOE/ER/45228–55
FG02-86ER45239	15:41030	Published article
	15:41294	Published article
FG02-86ER45267	15:42089	Published article
FG02-86ER53223	15:42204	Published article
FG02-87ER13749	**Lawrence Livermore National Lab., CA (USA)**	
	15:41754	UCRL-JC–103661
FG02-87ER40328	15:41944	Published article
FG02-87ER45295	15:41026	Published article
FG02-87ER45330	15:41097	Published article
FG02-87ER45334	15:42091	Published article
FG02-87ER60502	**Vermont Univ., Burlington, VT (USA)**	
	15:41700	DOE/ER/60502–4
FG02-87ER60577	**Pennsylvania State Univ., University Park, PA (USA)**	
	15:41589	DOE/ER/60577–T2
FG02-88ER13822	15:41823	Published article
FG02-88ER13916	15:41821	Published article
FG02-88ER13937	15:41809	Published article
	15:41810	Published article
FG02-88ER40388	15:41945	Published article
FG02-88ER40425	**Rochester Univ., NY (USA)**	
	15:42015	DOE/ER/40425–249
FG02-88ER40452	15:42089	Published article
FG02-88ER45347	**Ohio State Univ. Research Foundation, Columbus, OH (USA)**	
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FG02-89ER45391	15:41102	Published article
FG02-89ER69027	**Colorado State Univ., Fort Collins, CO (USA). Dept. of Atmospheric Science**	
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FG03-85ER13448	15:42088	Published article
FG03-86ER13527	15:41823	Published article
FG03-87ER13685	15:41292	Published article
FG03-87ER25028	**Stanford Univ., CA (USA). Systems Optimization Lab.**	
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FG03-87ER52146	**Rockwell International Corp., Canoga Park, CA (USA). Rocketdyne Div.**	
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FG03-88ER45378	15:41326	Published article
FG05-80ET53088	**Texas Univ., Austin, TX (USA). Inst. for Fusion Studies**	
	15:42150	DOE/ET/53088–338
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FG05-84ER40141	15:41783	Published article
	15:41969	Published article
FG05-85ER13368	15:41675	Published article
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FG05-85ER60290	**Virginia Univ., Charlottesville, VA (USA). Dept. of Environmental Sciences**	
	15:41531	DOE/ER/60290–4
FG05-86ER13461	**Maryland Univ., College Park, MD (USA). Dept. of Botany**	
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FG05-86ER40272	15:41865	Published article
FG05-86ER45233	**Rice Univ., Houston, TX (USA)**	
	15:42067	DOE/ER/45233–5
FG05-86ER45234	15:41099	Published article
FG05-87ER13674	15:41027	Published article
FG05-87ER25033	15:42200	Published article
FG05-87ER25048	**Texas Univ., Austin, TX (USA)**	
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	15:42285	CONF-9004231–1
	15:42287	DOE/ER/25048–T1
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	15:42289	DOE/ER/25048–T4
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FG05-87ER40374	**Houston Univ., TX (USA)**	
	15:41360	DOE/ER/40374–25
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	15:41364	DOE/ER/40374–40
	Texas Accelerator Center, The Woodlands, TX (USA)	
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FG05-87ER40380	**Hampton Univ., VA (USA). Dept. of Physics**	
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FG05-88ER13832	**Texas Tech Univ., Lubbock, TX (USA)**	
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FG05-88ER25067	**West Virginia Univ., Morgantown, WV (USA). Dept. of Mathematics**	
	15:41282	DOE/ER/25067–2
FG05-88ER40399	**Texas A and M Univ., College Station, TX (USA)**	
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	Texas A and M Univ., College Station, TX (USA). Dept. of Physics	
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FG05-88ER40467	Alabama Univ., Huntsville, AL (USA). Dept. of Physics	
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FG09-87ER13810		
	15:41674	Published article
FG09-87ER13811		
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FG09-87ER45291		
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FG22-83PC60808	North Dakota Univ., Grand Forks, ND (USA). Dept. of Chemistry	
	15:40282	DOE/PC/60808–T1
FG22-86PC90909		
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FG22-87PC79929	Brown Univ., Providence, RI (USA). Div. of Engineering	
	15:40321	DOE/PC/79929–9
FG22-88PC88940	Utah Univ., Salt Lake City, UT (USA). Dept. of Fuels Engineering	
	15:40283	DOE/PC/88940–T4
FG22-89BC14425	Geological Survey, Tuscaloosa, AL (USA)	
	15:40356	DOE/BC/14425–T4
W-31-109-ENG-38		
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	15:41145	Published article
	15:41677	Published article
W-31109-ENG-38	Argonne National Lab., Idaho Falls, ID (USA)	
	15:40391	ANL–89/44-Rev.1
	15:40651	CONF-900804–30
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	Argonne National Lab., IL (USA)	
	15:40273	CONF-900801–17
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	15:40652	CONF-900917–6
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	15:40697	ANL/PPRNT–90-211
	15:40779	CONF-9007119–1
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8	15:41427	*See* SSC–76			

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CONF-860870–		(13. international conference on high energy accelerators; Novosibirsk (USSR); 7-11 Aug 1986)			
21	15:41348	*See* SSC–85			
22	15:41347	*See* SSC–83			
23	15:41346	*See* SSC–81			
24	15:41395	*See* SSC–80			
CONF-8609135–		(International symposium on muon-catalyzed fusion; Tokyo (Japan); 1-3 Sep 1986)			
	15:42233	*See* INT–208/P			
CONF-8610108–		(2. joint US/CERN school on particle accelerators: frontiers of particle beams; South Padre Island, TX (USA); 23-29 Oct 1986)			
8	15:41404	*See* SSC–144			
CONF-861033–		(9. world energy engineering congress; Atlanta, GA (USA); 21-24 Oct 1986)			
1	15:40942	NTIS, PC A02/MF A01 - OSTI		DE90013668	MF-249
CONF-870302–		(Particle accelerator conference; Washington, DC (USA); 16-19 Mar 1987)			
259	15:41430	*See* SSC–112			
CONF-870339–		(Moriond meeting on hadrons, quarks and gluons; Les Arcs (France); 15-21 Mar 1987)			
	15:41881	*See* INP–1358/PH			
CONF-8705201–		(22. Zakopane school of physics; Zakopane (Poland); 1-8 May 1987)			
	15:42022	*See* INP–1370/PL			
CONF-8705406–		(5. Information seminar on the radiation protection dosemeter intercomparison programme; Bologna (Italy); 25-27 May 1987)			
	15:41455	*See* EUR–11363			
CONF-870632–		(International Europhysics conference on high energy physics; Uppsala (Sweden); 25 Jun - 1 jul 1987)			
21	15:41351	*See* SSC–136			
CONF-8706416–		(Workshop on mesonic degrees of freedom in hadrons; Bled-Ljubljana (Yugoslavia); 28 Jun 1987)			
	15:41882	*See* INP–1367/PL			
CONF-870821–		(SLAC summer institute on particle physics: looking beyond the Z; Stanford, CA (USA); 10-21 Aug 1987)			
16	15:41934	*See* SSC–154			
CONF-8710376–		(Symposium on dielectric films on compound semiconductors; Honolulu, HI (USA); 18-23 Oct 1987)			
	15:41044	*See* N–90-20393			
CONF-8711344–		(Ecole la physique des particules; Palaiseau (France); 18 Nov 1987)			
1	15:41355	*See* SSC–192			
CONF-8803269–		(Supercomputer applications of sparse matrix algorithms; Santa Cruz, CA (USA); 27-30 Mar 1988)			
1	15:42281	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90013972	MF-405
CONF-8806193–		(Workshop on relativistic gravitation experiments in space; Annapolis, MD (USA); 28-30 Jun 1988)			
	15:41773	*See* N–90-19940			
CONF-8806225–		(9. international seminar on high energy physics problems relativistic nuclear physics and quantum chromodynamics; Dubna (USSR); 14-19 Jun 1988)			
	15:41828	*See* JINR-D–1,2-88-652/v.1			
CONF-8810515–		(Conference on iterative methods for large linear systems; Austin, TX (USA); 19-21 Oct 1988)			
1	15:42282	NTIS, PC A05/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90013967	MF-405
2	15:42283	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90013963	MF-405
3	15:42284	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90013965	MF-405
CONF-8812139–		(RCA workshop on the WASP/MAED coomputer programs; Kuala Lumour (Malaysia); 5-9 Dec 1988)			
	15:40674	*See* IAEA-TECDOC–528			

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
CONF-8812140–		(3. EPRI seminar on chemical decontamination of BWR's; Charlotte, NC (USA); 6 Dec 1988)			
1	15:40769	*See* WHC-SA–0465			
CONF-8901194–		(8. meeting of the international working group on gas-cooled reactors; Vienna (Austria); 30 Jan 1989)			
	15:40635	*See* IWGGCR–20-1			
	15:40636	*See* IWGGCR–20-2			
CONF-8902168–		(21. lecture meeting of the DVM Study Group on francture mechanisms: fracture-mechanical characteristics for structural components evaluation; Bad Nauheim (Germany, F.R.); 27-28 Feb 1989)			
	15:40983	*See* GKSS–89/E/43			
CONF-8902188–		(3. infrared detector technology workshop; Moffett Field, CA (USA); 7-9 Feb 1989)			
	15:41487	*See* N–90-21313			
CONF-8902189–		(Discussion of an EMF protocol; Elkridge, MD (USA); 6-8 Feb 1989)			
	15:41747	*See* EPRI-EN–6829			
CONF-890240–		(Society of Automotive Engineers international congress and exposition; Detroit, MI (USA); 27 Feb - 3 mar 1989)			
6	15:40953	NTIS, PC A02/MF A01 - OSTI		DE90013667	MF-331
CONF-8903226–		(Symposium on data acquisition and processing for next generation experiments; Tsukuba (Japan); 9-10 Mar 1989)			
	15:42316	*See* KEK–89-26			
CONF-8903227–		(3. DSV special meeting: Robots '89 - arc welding, arc cutting, related processes; Fellbach (Germany, F.R.); 8-10 Mar 1989)			
	15:41295	*See* GKSS–89/E/6			
CONF-890352–		(US Department of Energy research and development for the geothermal marketplace: 7th geothermal program review; San Francisco, CA (USA); 21-23 Mar 1989)			
11	15:40568	*See* LBL–26899			
CONF-8904196–		(2. space electrochemical research and technology conference; Cleveland, OH (USA); 11-13 Apr 1989)			
	15:40846	*See* N–90-20454			
CONF-8904364–		(22. annual meeting of the International Working Group on Fast Reactors; Vienna (Austria); 18-21 Apr 1989)			
	15:40654	*See* IWGFR–70			
CONF-8905134–		(JANNAF propulsion meeting; Cleveland, OH (USA); 22-25 May 1989)			
	15:40946	*See* CPIA-PUBL–515-VOL-1			
CONF-8905220–		(KEK topical conference on e^+e_- collision physics; Tsukuba (Japan); 17-19 May 1989)			
	15:41798	*See* KEK–89-23			
CONF-8905332–		(4. Hampton University graduate studies (HUGS) at the continuous electron beam accelerator facility (CEBAF); Hampton, VA (USA); 30 May - 17 jun 1989)			
	15:41827	*See* DOE/ER/40380–2			
CONF-8905336–		(Proceedings of the predator-prey modeling workshop; Friday Harbor, WA (USA); 16-19 May 1989)			
Summ.	15:40487	*See* DOE/BP–01830-5			
CONF-890604–		(Annual meeting of the American Nuclear Society; Atlanta, GA (USA); 4-8 Jun 1989)			
	15:40609				
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Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
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CONF-8906334–		(1989 NASA/ASEE summer faculty fellowship program; Huntsville, AL (USA); 5 Jun 1989)			
	15:42253	*See* N–90-19390			
CONF-890673–		(IWGFR specialists meeting on advanced controls for fast reactors; Argonne, IL (USA); 20-22 Jun 1989)			
	15:40706	*See* IWGFR–71			
CONF-8907143–		(Workshop on annihilation in gases and galaxies; Greenbelt, MD (USA); 19-21 Jul 1989)			
	15:41772	*See* N–90-18957			
CONF-8907203–		(Trieste conference on supermembranes and physics in 2 + 1 dimensions; Trieste (Italy); Jul 1989)			
1	15:41955	*See* IC–90/51			

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
CONF-890786–		(US particle accelerator school; Upton, NY (USA); 24 Jul - 4 aug 1989)			
2	15:41438	*See* SSCL–255			
CONF-890803–		(International conference on high energy accelerators; Tsukuba (Japan); 20-26 Aug 1989)			
53	15:41361	*See* DOE/ER/40374–32			
CONF-890810–		(Seminar on small and medium sized reactors, design, safety and marketing potential; San Diego, CA (USA); 21-23 Aug 1989)			
	15:40649	*See* CEA-CONF–9957			
CONF-890815–		(24. intersociety energy conversion engineering conference; Arlington, VA (USA); 6-11 Aug 1989)			
	15:40667	*See* CEA-CONF–10000			
	15:40668	*See* CEA-CONF–10001			
CONF-890821–		(13. international conference on atomic collisions in solids; Aarhus (Denmark); 7-11 Aug 1989)			
	15:42080	*See* KU-HCOE-FL2-R–90-2			
CONF-8908239–		(4. workshop on RF superconductivity; Tsukuba (Japan); 14-18 Aug 1989)			
	15:41315	*See* KEK–89-21			
CONF-890855–		(10. international conference on Structural Mechanics in Reactor Technology (SMIRT); Anaheim, CA (USA); 14-18 Aug 1989)			
	15:40613	*See* CEA-CONF–9993			
	15:40614	*See* CEA-CONF–9994			
	15:40615	*See* CEA-CONF–9997			
	15:40616	*See* CEA-CONF–9999			
	15:40650	*See* CEA-CONF–9988			
	15:40974	*See* CEA-CONF–9998			
	15:40975	*See* CEA-CONF–10013			
	15:42269	*See* CEA-CONF–9989			
	15:42270	*See* CEA-CONF–9990			
	15:42271	*See* CEA-CONF–9991			
	15:42272	*See* CEA-CONF–9992			
	15:42273	*See* CEA-CONF–9995			
	15:42274	*See* CEA-CONF–9996			
	15:42275	*See* CEA-CONF–10002			
	15:42276	*See* CEA-CONF–10003			
	15:42277	*See* CEA-CONF–10004			
	15:42278	*See* CEA-CONF–10005			
	15:42279	*See* CEA-CONF–10012			
CONF-890916–		(6. annual international Pittsburgh coal conference; Pittsburgh, PA (USA); 25-29 Sep 1989)			
6	15:40284	*See* EGG-M–89236			
CONF-8909297–		(11. annual international meeting of the Alternative Natural Philosophy Association; Cambridge (UK); 14-17 Sep 1989)			
2	15:41933	*See* SLAC-PUB–5085			
CONF-8909299–		(5. French-Japanese symposium on nuclear physics; Dogashima (Japan); 26-30 Sep 1989)			
2	15:42013	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90014349	MF-413
CONF-8910240–		(Fundamental relationships between microstructure and mechanical properties of metal matrix composites symposium; Indianapolis, IN (USA); 1-5 Oct 1989)			
	15:40995	*See* N–90-21138			
CONF-8910260–		(Plutonium/uranium recovery operations conference; Oak Ridge, TN (USA); 24-26 Oct 1989)			
6	15:40396	*See* WHC-SA–0641			
CONF-891029–		(ECASIA 89: European conference on applications of surface and interface analysis; Juan-les-Pins (France); 23-27 Oct 1989)			
	15:40984	*See* GKSS–89/E/58			
CONF-8910337–		(Conference on environmental research with plants in closed chambers; Munich (Germany, F.R.); 9-11 Oct 1989)			
2	15:41527	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90013382	MF-402

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
CONF-8910431–		(137. IAU symposium on flare stars; Armenia (USSR); 23 Oct 1989)			
	15:41778	*See* N–90-21719			
CONF-891057–		(3. international symposium on borehole geophysics; Las Vegas, NV (USA); 2-5 Oct 1989)			
5	15:41753	*See* EGG-M–89243			
CONF-891098–		(The scientific challenges of NEPA: future directions based on 20 years of experience; Knoxville, TN (USA); 24-27 Oct 1989)			
8	15:41717	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90014204	
CONF-891135–		(ISTFA '89: international symposium for testing and failure analysis; Los Angeles, CA (USA); 6-10 Nov 1989)			
	15:40994	*See* N–90-21123			
CONF-8912104–		(142. IAU symposium on basic plasma processes on the sun; Bangalore (India); 1-5 Dec 1989)			
	15:41777	*See* N–90-21711			
CONF-8912105–		(Proceedings of the anadromous fish release strategies workshop; Eagle Creek, OR (USA); 11-14 Dec 1989)			
Summ.	15:41616	*See* DOE/BP–01830-7			
CONF-8912106–		(Workshop on low-dimensional quantum field theory and its applications; Tanashi (Japan); 18-20 Dec 1989)			
	15:41884	*See* INS-T–493			
CONF-900102–		(13. energy-sources technology conference and exhibition; New Orleans, LA (USA); 14-18 Jan 1990)			
	15:41079	*See* N–90-20138			
CONF-9001103–		(4. US/USSR bilateral symposium on the physics of optical phenomena; Irvine, CA (USA); 23-27 Jan 1990)			
1	15:42084	*See* LBL–28526			
CONF-9001105–		(Hatchery effectiveness technical work group meeting (HETWG); Gleneden Beach, OR (USA); 9-11 Jan 1990)			
Summ.	15:41615	*See* DOE/BP–01830-6			
CONF-9001106–		(1990 JOWOG - 37 meeting; Albuquerque, NM (USA); 22-25 Jan 1990)			
1	15:42247	*See* SAND–90-1841C			
CONF-900143–		(Institute for Electronic and Electrical Engineers (IEEE) nuclear science symposium; San Francisco, CA (USA); 15-19 Jan 1990)			
35	15:41478	*See* LBL–28667			
CONF-900147–		(13. symposium on nuclear physics; Oaxtepec (Mexico); 3-6 Jan 1990)			
3	15:41993	*See* LBL–29014			
CONF-900153–		(28. AIAA aerospace sciences meeting; Reno, NV (USA); 8-11 Jan 1990)			
	15:41286	*See* N–90-20426			
CONF-900182–		(Computer simulation 1990 multiconference; San Diego, CA (USA); 17-19 Jan 1990)			
2	15:40917	*See* LBL–28273			
CONF-900193–		(Division of particle; Houston, TX (USA); 2 Jan 1990)			
3	15:41833	*See* FNAL/C–90/127-E			
CONF-9002130–		(Fisheries-oceanography coordinated investigation (FOCI) workshop on fisheries recruitment modelling; Seattle, WA (USA); 26-27 Feb 1990)			
1	15:41613	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90013826	
CONF-900218–		(3. international conference on ceramic powder processing science; San Diego, CA (USA); 4-7 Feb 1990)			
4	15:41036	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90013830	MF-332
CONF-900289–		(International workshop on the polarized ion sources and polarized gas jets; Tsukuba-Shi (Japan); 12-17 Feb 1990)			
6	15:42011	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90014348	MF-413

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
CONF-900306–		(International symposium on performance improvement, retrofitting and repowering of fossil fuel power plants: GEN-UPGRADE '90; Washington, DC (USA); 6-9 Mar 1990)			
1	15:40585	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90013690	MF-101
CONF-9003161–		(25. Rencontres de Moriond on QCD and hadronic interactions conference; Les Arcs (France); Mar 1990)			
9	15:41832	*See* FNAL/C–90/126-E			
CONF-900331–		(Workshop on heavy ion physics at the alternating gradient synchrotron; Upton, NY (USA); 3-7 Mar 1990)			
12	15:41979	*See* LBL–29076			
CONF-900384–		(American Physical Society meeting; Anaheim, CA (USA); 12-16 Mar 1990)			
	15:41082	*See* N–90-20886			
CONF-900388–		(International workshop on software engineering, artificial intelligence and expert systems for high energy and nuclear physics; Lyon (France); 19-24 Mar 1990)			
4	15:42012	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90014212	MF-414
CONF-900402–		(199. national meeting of the American Chemical Society; Boston, MA (USA); 22-27 Apr 1990)			
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	15:41131	American Chemical Society, Distribution Dept. 408, 1155 16th St., N.W. Washington, D.C. 20036			
CONF-900410–		(International conference on low-temperature electronics: semiconducting–superconducting; Berkeley, CA (USA); 23-26 Apr 1990)			
4	15:40947	*See* LBL–28944			
CONF-9004112–		(Workshop on hadron structure functions and parton distributions; Batavia, IL (USA); 26-28 Apr 1990)			
3	15:41831	*See* FNAL/C–90/125-E			

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
CONF-900419–		(8. international triennial conference on thin films and the 17th international conference on metallurgical coatings; San Diego, CA (USA); 1-6 Apr 1990)			
	15:40564	*See* N–90-21110			
6	15:41067	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90014214	
CONF-9004211–		(3. international conference on charged particle optics; Toulouse (France); 24-27 Apr 1990)			
2	15:41424	*See* SLAC-PUB–5217			
CONF-9004212–		(31. AIAA/ASME/ASCE/AHS/ASC structures, structural dynamics and materials conference; Long Beach, CA (USA); 2-4 Apr 1990)			
	15:41080	*See* N–90-20139			
CONF-9004220–		(International workshop on nuclear dynamics; Elba (Italy); 2-7 Apr 1990)			
2	15:41994	*See* LBL–29090			
CONF-9004228–		(Informal spring workshop on quantum groups; Argonne, IL (USA); 26 Apr - 11 may 1990)			
1	15:42102	*See* ANL-HEP-CP–90-32			
CONF-900423–		(13. international cryogenic engineering conference (ICEC-13); Beijing (China); 24-27 Apr 1990)			
1	15:41422	*See* LBL–28913			
CONF-9004230–		(Workshop on non-linear problems in future particle accelerators; Capri (Italy); 19-25 Apr 1990)			
1	15:41367	*See* LBL–28931			
CONF-9004231–		(Conference on iterative methods; Copper Mountain, CO (USA); 1-5 Apr 1990)			
1	15:42285	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90013964	MF-405
CONF-9004232–		(1. Angstrom FEL workshop; Sag Harbor, NY (USA); 22-27 Apr 1990)			
1	15:41410	*See* BNL–44611			
CONF-900439–		(35. international symposium and exhibition of the Society for the Advancement of Material and Process Engineers: advanced materials: the challenge for the next decade; Anaheim, CA (USA); 2-5 Apr 1990)			
	15:41081	*See* N–90-20151			
	15:41083	*See* N–90-21124			
	15:41085	*See* N–90-21143			
CONF-900449–		(12. annual American Society of Mechanical Engineers (ASME) international solar energy conference; Miami, FL (USA); 1-4 Apr 1990)			
	15:40498	*See* N–90-21274			
CONF-900450–		(Nuclear structure in the '90's; Oak Ridge, TN (USA); 23-27 Apr 1990)			
	15:42017	*See* GSI–90-24(prepr.)			
CONF-900466–		(Spring meeting of the Materials Research Society; San Francisco, CA (USA); 16-21 Apr 1990)			
71	15:40274	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90013832	MF-114; MF-310
72	15:40976	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90013817	MF-404
73	15:41077	*See* LBL–29035			
CONF-900505–		(9. plasma surface interactions in controlled fusion devices conference; Bournemouth (UK); 20-25 May 1990)			
8	15:42156	*See* GA-A–20076			
CONF-9005112–		(Innovations in pricing and planning; Milwaukee, WI (USA); 2-4 May 1990)			
1	15:40890	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90013684	MF-220; MF-331
CONF-9005195–		(METC contractors review meeting; Morgantown, WV (USA); 2-3 May 1990)			
2	15:40897	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90013896	MF-110
CONF-9005221–		(Interface between nuclear structure and heavy-ion reaction dynamics conference; Notre Dam, IN (USA); 24-26 May 1990)			
6	15:42014	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90013679	MF-413

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
CONF-9005233–		(International conference on medium- and high-energy physics; Taipei (Taiwan); 14-18 May 1990)			
2	15:41771	*See* LBL–29081			
CONF-9005235–		(7. international symposium on molten salts; Spring meeting of the Electrochemical Society; Montreal (Canada); Montreal (Canada); 6-11 May 1990; 6-11 may 1990)			
2	15:41039	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90013682	MF-401; MF-404
CONF-9005241–		(OECD/TMI-2 joint task group meeting; Tokyo (Japan); 22 May 1990)			
1	15:40781	*See* EGG-M–90229			
CONF-9005244–		(Mycotoxins, cancer and health conference; Baton Rouge, LA (USA); 17-18 May 1990)			
1	15:41668	*See* LBL–29028			
CONF-9005245–		(International workshop on correlations and multiparticle production (CAMP); Marburg (Germany, F.R.); 14-16 May 1990)			
1	15:41829	*See* ANL-HEP-CP–90-54			
CONF-9005246–		(SIGMOD 1990; Atlantic City, NJ (USA); 23-25 May 1990)			
1	15:42317	*See* LBL–28566			
CONF-900534–		(18. NATO/CCMS international technical meeting on air pollution modelling and its applications; Vancouver (Canada); 13-17 May 1990)			
2-Rev.1	15:41663	*See* UCRL-JC–103587-Rev.1			
CONF-900556–		(Hazardous waste site investigations: toward better decisions; Gatlinburg, TN (USA); 21-24 May 1990)			
1	15:40868	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90014209	MF-407
CONF-900562–		(7. international symposium on molten salts; Spring meeting of the Electrochemical Society; Montreal (Canada); Montreal (Canada); 6-11 May 1990; 6-11 may 1990)			
7	15:41039	*See* CONF-9005235–2			
CONF-900563–		(7. symposium on radiation measurements and applications; Ann Arbor, MI (USA); 21-24 May 1990)			
9	15:41452	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90011702	MF-406; MF-413
15	15:42229	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90013683	MF-420
CONF-900602–		(17. European conference on controlled fusion and plasma heating; Amsterdam (Netherlands); 25-29 Jun 1990)			
	15:42144	*See* LRP–403/90			
12	15:42154	*See* GA-A–20057			
16	15:42146	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90014046	MF-421
17	15:42147	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90014097	MF-421
18	15:42155	*See* GA-A–20058			
19	15:42148	*See* DOE/ER/53198–156			
20	15:42157	*See* GA-A–20081			
CONF-900603–		(2. European particle accelerator conference; Nice (France); 11-16 Jun 1990)			
25	15:41358	*See* BNL–43678			
25	15:41363	*See* DOE/ER/40374–39			
CONF-900608–		(American Nuclear Society annual meeting; Nashville, TN (USA); 10-14 Jun 1990)			
44	15:40766	*See* LA-UR–90-1963			
45	15:40416	*See* LBL–28429			
47	15:40415	*See* LBL–28428			
48	15:40417	*See* LBL–28430			
49	15:40450	*See* WHC-SA–0825			
CONF-9006105–		(28. symposium on engineering aspects of magnetohydrodynamics; Chicago, IL (USA); 26-28 Jun 1990)			
9	15:40896	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90013673	
CONF-9006121–		(4. international SAMPE electronic materials and processes conference; Albuquerque, NM (USA); 12-14 Jun 1990)			
7	15:41317	*See* MLM–3644(OP)			

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CONF-9006153–		(21. AIAA fluid dynamics, plasmadynamics and laser conference in conjuction with the AIAA 25th thermophysics and heat transfer conference and the 16th aerodynamic ground testing conference; Seattle, WA (USA); 18-20 Jun 1990)			
2	15:41816	*See* UCRL–102303			
3	15:41817	*See* UCRL–102304			
CONF-900617–		(Pressure vessels and piping conference: be in tune for the 90's; Nashville, TN (USA); 17-21 Jun 1990)			
17	15:41277	*See* SAND–90-1247C			
CONF-9006175–		(Meeting of the American Society for Engineering Education; Toronto (Canada); Jun 1990)			
2	15:41509	*See* LA-UR–90-2043			
CONF-9006178–		(1990 Society of Women Engineers national convention and student conference; New York, NY (USA); 24 Jun - 1 jul 1990)			
2	15:40666	*See* WHC-SA–0842			
CONF-9006179–		(5. national conference on high-power microwave technology; West Point, NY (USA); 10-15 Jun 1990)			
3	15:41507	*See* UCRL-JC–103714			
4	15:41323	*See* UCRL–102516			
CONF-9006221–		(Annual technology transfer society meeting; Dayton, OH (USA); 28 Jun 1990)			
2	15:40876	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90013659	MF-400
CONF-9006227–		(TMS symposium on high performance composites for the 1990's; Morristown, NJ (USA); 6-8 Jun 1990)			
1	15:41069	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90013674	MF-404
CONF-9006228–		(1990 annual charged particle beam meeting; San Diego, CA (USA); 11-14 Jun 1990)			
1	15:41332	*See* SAND–90-1938C			
CONF-9006231–		(ASGS '90: American scientific glassblowers society conference; Orlando, FL (USA); 25-29 Jun 1990)			
1	15:41718	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90013660	MF-407
2	15:41072	*See* DOE/ER/00038–3300			
CONF-9006232–		(International workshop on assessing winners and losers in the contex of global warming; St. Julians (Malta); 18-21 Jun 1990)			
1	15:41528	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90013658	MF-402
CONF-9006233–		(USA-USSR radioactive waste management exchange meeting; Moscow (USSR); 20 Jun 1990)			
1	15:40400	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90013280	MF-721
CONF-9006234–		(Symposium on access and use of information resources in assessing health risks from chemical exposure; Oak Ridge, TN (USA); 27-29 Jun 1990)			
2	15:41719	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90014220	MF-407
Suppl.	15:41720	*See* ORNL/M–1207			
CONF-9006235–		(114. enrico fermi school of physics; La Specia (Italy); 19-29 Jun 1990)			
1	15:40474	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90013381	MF-413
CONF-9006240–		(American society for testing and materials symposium on water in the 1990's: meeting new challenges; Denver, CO (USA); 11-14 Jun 1990)			
1	15:40448	*See* WHC-SA–0646			
CONF-9006241–		(38. ASMS conference on mass spectrometry and allied topics; Tucson, AZ (USA); 4-8 Jun 1990)			
1	15:41505	*See* MLM–3642(OP)			
2	15:41121	*See* MLM–3643(OP)			
3	15:41078	*See* MLM–3641(OP)			
CONF-9006242–		(Workshop on short pulse high current cathodes; Bendor (France); 18-22 Jun 1990)			
1	15:41425	*See* SLAC-PUB–5257			

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CONF-9006243–		(8. beta battery workshop; Chester (UK); 12-18 Jun 1990)			
1	15:40866	*See* SAND–90-1829C			
CONF-900628–		(17. international conference for the electric power industry: reliability, availability, maintainability strategies for the 90's; Hershey, PA (USA); 12-15 Jun 1990)			
2	15:40889	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90013675	MF-101
CONF-900634–		(7. world ceramics congress: ceramics today–tomorrow's ceramics; Montecatini Terme (Italy); 24-30 Jun 1990)			
3	15:42230	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90013672	MF-422
4	15:41037	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90013822	MF-332
CONF-900658–		(NATO advanced study institute on techniques and concepts of high energy physics; St. Croix (Virgin Islands (U.S.)); 14-25 Jun 1990)			
1	15:41952	*See* DOE/ER/13065–630			
CONF-900704–		(23. Combustion Institute symposium on combustion; Orleans (France); 22-27 Jul 1990)			
11	15:41249	*See* LBL–28884			
CONF-9007106–		(Institute of nuclear materials management conference; Los Angeles, CA (USA); 15-18 Jul 1990)			
7	15:41120	*See* LA-UR–90-2000			
13	15:40464	*See* SAND–90-0723C			
14	15:40393	*See* SAND–90-0767C			
16	15:40465	*See* SAND–90-0770C			
19	15:41273	*See* SAND–90-0669C			
20	15:40969	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90013653	MF-700
21	15:40467	*See* SAND–90-0774C			
22	15:41497	*See* SAND–90-0768C			
23	15:41272	*See* SAND–90-0666C			
25	15:41275	*See* SAND–90-0771C			
26	15:42308	*See* SAND–90-0047C			
27	15:41274	*See* SAND–90-0764C			
28	15:40466	*See* SAND–90-0772C			
29	15:42310	*See* SAND–90-0754C			
30	15:40463	*See* SAND–90-0668C			
35	15:40401	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90014451	MF-400
CONF-9007118–		(Hearing on the national energy strategy, energy and public health; Bethesda, MD (USA); 6 Jul 1990)			
1	15:40869	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90013390	MF-630
CONF-9007119–		(International workshop on intelligent structures; Taiwan (China); 23-26 Jul 1990)			
1	15:40779	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90013671	
CONF-900726–		(International conference on polarization phenomena in nuclear physics; Paris (France); 9-13 Jul 1990)			
1	15:41440	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90013655	MF-413
CONF-900731–		(NATO Advisory Study Institute on diamond and diamond-like films; Castelvecchio Pascoli (Italy); 22 Jul - 2 aug 1990)			
1	15:41068	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90014456	MF-404
CONF-900734–		(5. Pacific Rim coal conference; Denver, CO (USA); 22-25 Jul 1990)			
1	15:40349	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90013654	MF-101
CONF-900738–		(8. American conference on crystal growth; Vail, CO (USA); 15-20 Jul 1990)			
1	15:41038	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90013657	MF-404
2	15:42100	*See* SAND–90-1573C			
CONF-900757–		(15. international conference on x-ray and inner-shell processes; Knoxville, TN (USA); 9-13 Jul 1990)			
Vol.1-Absts.	15:41805	*See* ORNL/M–1206-Vol.1			
CONF-900764–		(Fatigue '90 international conference; Honolulu, HI (USA); 15-20 Jul 1990)			
	15:41086	*See* N–90-21409			
CONF-900773–		(IEEE/PES 1990 summer meeting; Minneapolis, MN (USA); 15-20 Jul 1990)			
3	15:40829	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90013929	MF-220

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
CONF-900801–		(25. intersociety energy conversion engineering conference; Reno, NV (USA); 12-17 Aug 1990)			
	15:40862	*See* N–90-21116			
17	15:40273	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90013891	MF-311
18	15:40895	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90013651	
19	15:40842	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90013650	MF-212
20	15:40843	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90013649	MF-331
21	15:40844	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90013895	MF-331
22	15:40586	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90013894	MF-310
CONF-900804–		(International topical meeting on fast reactor safety; Snowbird, UT (USA); 12-16 Aug 1990)			
30	15:40651	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90013893	MF-540
31	15:40774	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90013892	MF-540
CONF-9008124–		(1990 DOE/Sandia crystalline photovoltaic technology project review meeting; Albuquerque, NM (USA); 7-9 Aug 1990)			
1	15:40504	*See* SAND–90-1767C			
CONF-9008126–		(Beijing international symposium on climate change; Beijing (China); 9-12 Aug 1990)			
1	15:41529	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90014345	MF-402
2	15:41530	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90014344	MF-402
CONF-900818–		(International conference on shock wave and high-strain-rate phenomena in materials; San Diego, CA (USA); 12-17 Aug 1990)			
2	15:41004	*See* UCRL-JC–103259			
CONF-900828–		(Summer national meeting of the American Institute of Chemical Engineers; San Diego, CA (USA); 19-22 Aug 1990)			
3	15:40469	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90013829	MF-820
4	15:40775	NTIS, PC A04/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90014215	MF-523
CONF-900833–		(ACEEE summer study on energy efficiency in buildings; Pacific Grove, CA (USA); 26 Aug - 1 sep 1990)			
4	15:40912	NTIS, PC A02/MF A01 - OSTI		DE90013384	MF-350
5	15:40913	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90013834	MF-350
CONF-900901–		(World renewable energy congress; Reading (UK); 23-28 Sep 1990)			
1	15:40556	*See* SERI/TP–211-3679			
CONF-900907–		(Annual meeting of the Society of Exploration Geophysicists; San Francisco, CA (USA); 23-27 Sep 1990)			
1	15:41754	*See* UCRL-JC–103661			
2	15:40358	*See* LA-UR–90-1514			
CONF-9009110–		(Joint ANS/ASME nuclear engineering conference; Newport, RI (USA); 16-20 Sep 1990)			
1	15:40402	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90009243	MF-721
2	15:40403	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90012174	MF-721
CONF-9009116–		(Spectrum '90: radioactive waste technologies, decontamination, decommissioning and hazardous wastes; Knoxville, TN (USA); 30 Sep - 4 oct 1990)			
2	15:40914	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90011312	MF-402; MF-405
3	15:40451	*See* WHC-SA–0826			
CONF-9009117–		(Certification of process gage design review meeting; Livermore, CA (USA); 20-21 Sep 1990)			
1	15:41322	*See* UCRL–100330			
CONF-9009125–		(10. international conference on conduction and breakdown in dielectric liquids; Grenoble (France); 10-14 Sep 1990)			
1	15:42066	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90009815	MF-411
2	15:41254	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90009425	MF-406
CONF-9009128–		(Nuclear congress and technology/industry expo; Geneva (Switzerland); 23-28 Sep 1990)			
1	15:40449	*See* WHC-SA–0657			
CONF-9009134–		(ENVIRONSOFT '90: 3. international conference; Montreal (Canada); 11-13 Sep 1990)			
1	15:41536	*See* LA-UR–90-1386			

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CONF-9009136–		(3. international aerosol conference; Kyoto (Japan); 24-27 Sep 1990)			
1	15:41526	*See* BNL–43549			
2	15:41576	*See* SAND–90-1795C			
CONF-9009141–		(International symposium on metal-hydrogen systems; Banff (Canada); 2-7 Sep 1990)			
1	15:41127	*See* LA-UR–90-1762			
2	15:41244	*See* K/CSD/INF–89/42			
3	15:41002	*See* SAND–90-0016C			
CONF-9009147–		(International conference on fabrication of particulates reinforced metal composites; Montreal (Canada); 16-19 Sep 1990)			
1	15:41070	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90014448	MF-404
CONF-9009150–		(Sensors expo conference; Chicago, IL (USA); 11-13 Sep 1990)			
2	15:41495	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90011707	MF-406
3	15:41453	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90011649	MF-405; MF-406
CONF-9009152–		(2. workshop on subsecond thermophysics; Torino (Italy); 20-21 Sep 1990)			
1	15:41494	*See* UCRL–102751			
2	15:41493	*See* UCRL–102750			
CONF-9009153–		(17. annual conference of the American Society for Quality Control; Tucson, AZ (USA); 9-12 Sep 1990)			
1	15:42254	*See* FNAL/C–90/65			
CONF-9009155–		(Advanced machining technology III; Chicago, IL (USA); 11 Sep 1990)			
1	15:41316	*See* LA-UR–90-1848			
CONF-900917–		(American Nuclear Society topical meeting on safety of non-commercial nuclear reactor research and irradiation facilities; Boise, ID (USA); 30 Sep - 3 oct 1990)			
1	15:40806	*See* SAND–90-0115C			
2	15:40670	*See* WHC-SA–0817			
3	15:40776	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90012732	MF-523
4	15:40777	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90012796	MF-407
5	15:40780	*See* EGG-M–90063			
6	15:40652	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90013664	MF-532
7	15:40653	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90013665	MF-530
8	15:40778	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90013828	MF-400
9	15:40811	*See* WHC-SA–0822			
CONF-9009172–		(Close combat light simulations technology conference; Albuquerque, NM (USA); 17-20 Sep 1990)			
1	15:40462	*See* EGG–10617-6070			
CONF-9009176–		(International ORACLE User Group conference; Anaheim, CA (USA); 24-28 Sep 1990)			
1	15:42314	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90012729	
2	15:42315	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90012735	
3	15:42319	*See* SAND–90-0592C			
CONF-9009178–		(Spectrum 90 international topical meeting; Knoxville, TN (USA); 30 Sep - 4 oct 1990)			
1	15:40404	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90012736	MF-606
2	15:41614	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90012737	MF-606
CONF-9009183–		(3. international Lavrentiev's readings conference; Novosibirsk (USSR); 10-14 Sep 1990)			
1	15:41512	*See* UCRL-JC–103218			
CONF-9009191–		(Animals to animates conference; Paris (France); Sep 1990)			
1	15:41128	*See* LA-UR–90-1959			
CONF-9009192–		(Discharges and electrical insulation in vacuum; Santa Fe, NM (USA); 17-20 Sep 1990)			
1	15:41800	*See* LA-UR–90-2092			
2	15:41278	*See* UCRL-JC–103233			
CONF-9009200–		(1990 LINAC conference; Albuquerque, NM (USA); 10-14 Sep 1990)			
1	15:41368	*See* SLAC-PUB–5220			

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CONF-9009205–		(International conference on organohalogen compounds (DIOXINE 90); Bayreuth (Germany, F.R.); 10-14 Sep 1990)			
1	15:41113	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90013666	MF-401
CONF-9009209–		(Golden jubilee meeting of the British society of rheology and 3. European rheology conference; Edinburgh (UK); 3-7 Sep 1990)			
1	15:41504	*See* LBL–29040			
CONF-9009219–		(1990 joint RELAP5 and TRAC-BWR international user seminar; Chicago, IL (USA); 17-21 Sep 1990)			
1	15:40788	*See* K/CSD/INF–90/28			
CONF-900930–		(17. International Council of Aeronautical Sciences (ICAS) meeting; Stockholm (Sweden); 9-14 Sep 1990)			
1	15:41270	*See* SAND–89-0874C			
CONF-900955–		(2. international conference on power beam technology: laser and electronic beam conference; Stratford-upon-Avon (UK); 23-26 Sep 1990)			
1	15:40988	*See* LA-UR–90-827			
CONF-900977–		(Spectrum '90: working toward a cleaner environment; Knoxville, TN (USA); 30 Sep - 4 oct 1990)			
1	15:40399	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90011387	MF-402
CONF-900978–		(COMODIA '90: international symposium on diagnostics and modeling of combustion in internal combustion engines; Kyoto (Japan); 3-5 Sep 1990)			
1	15:40951	*See* UCRL-JC–103593			
CONF-900980–		(3. ENS/ANS/FORATOM joint European Nuclear Congress and technology/industry exposition: looking into nuclear's future in the 21st century; Lyon (France); 23-28 Sep 1990)			
1	15:40812	*See* WHC-SA–0966			
CONF-900983–		(Workshop on physical techniques in medical sciences; Calcutta (India); Sep 1990)			
1	15:41704	*See* LA-UR–90-355			
CONF-900992–		(CONPAR '90: international conference on parallel processing; Zurich (Switzerland); 10-13 Sep 1990)			
1	15:42313	*See* UCRL–102791			
2	15:42280	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90011108	MF-405
CPIA-PUBL–					
515-VOL-1	15:40946	NTIS, PC A25/MF A04			
CRIE-T–					
89015	15:41312	NTIS (US Sales Only), PC A03/MF A01		DE90507869	
89017	15:40591	NTIS (US Sales Only), PC A03/MF A01		DE90507868	
CRIE-U–					
89022	15:41255	NTIS (US Sales Only), PC A03/MF A01		DE90507847	
89023	15:41684	NTIS (US Sales Only), PC A03/MF A01		DE90507853	
89024	15:41256	NTIS (US Sales Only), PC A03/MF A01		DE90507846	
89026	15:40485	NTIS (US Sales Only), PC A04/MF A01		DE90507852	
89042	15:40275	NTIS (US Sales Only), PC A03/MF A01		DE90507845	
CRIE-W–					
89002	15:40832	NTIS (US Sales Only), PC A03/MF A01		DE90507840	
89004	15:40337	NTIS (US Sales Only), PC A03/MF A01		DE90507870	
89012	15:40898	NTIS (US Sales Only), PC A03/MF A01		DE90507841	
89014	15:40276	NTIS (US Sales Only), PC A03/MF A01		DE90507871	
89016	15:40592	NTIS (US Sales Only), PC A03/MF A01		DE90507881	
89019	15:40833	NTIS (US Sales Only), PC A03/MF A01		DE90507886	
89020	15:41071	NTIS (US Sales Only), PC A04/MF A01		DE90507842	
89022	15:40899	NTIS (US Sales Only), PC A03/MF A01		DE90507884	
89023	15:40834	NTIS (US Sales Only), PC A03/MF A01		DE90507885	
89024	15:40835	NTIS (US Sales Only), PC A03/MF A01		DE90507843	
89025	15:40828	NTIS (US Sales Only), PC A03/MF A01		DE90507844	
CRREL-SP–					
90-2	15:41612	*See* AD-A–220610/0/XAB			
DCN–					
89-245-052-04	15:41566	*See* PB–90-223751/XAB			

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DF/P–					
1-90/519	15:41513	*See* AD-A–220038/4/XAB			
DOCKET–					
71-9231-Vol.1	15:41262	*See* DOE/ID/12702–1-Vol.1			
71-9231-Vol.2	15:41263	*See* DOE/ID/12702–1-Vol.2			
DOD–					
5126.46-M	15:42318	*See* PB–90-215815/XAB			
DOE–					
76-45/37	15:41751	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90014195	MF-607
DOE/AL/58309–					
45	15:41508	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90014367	MF-721
DOE/BC–					
89/4	15:40359	NTIS, PC A06/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90000219	PC-122
DOE/BC/14425–					
T4	15:40356	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90014379	MF-122
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01830-5	15:40487	NTIS, PC A04/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90014149	MF-902
01830-6	15:41615	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90014146	MF-902
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6	15:40488	NTIS, PC A04/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90014150	MF-630
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39	15:41363	NTIS, PC A02/MF A01; OSTI; INIS		DE90014356	MF-414
40	15:41364	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90014359	MF-414
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2	15:41827	NTIS, PC A15/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90013957	MF-414
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DOE/ER/40467–					
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DOE/ER/45233–					
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DOE/NP–

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DOE/OR/20722–					
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DOE/PC/60422–					
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DOE/PC/60808–					
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DOE/PC/88940–					
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DOE/PC/90751–					
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89-03-Rev.1	15:40405	NTIS, PC A99/MF A01 - OSTI		DE90014394	MF-510
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5090	15:40994	*See* N–90-21123			
5156	15:40995	*See* N–90-21138			
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EGG–					
10282-1095	15:41592	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90014193	MF-707

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89236	15:40284	NTIS, PC A02/MF A01 - OSTI		DE90013868	MF-102
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540/8-89/005	15:40874	*See* PB–90-214354/XAB			
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0507354	15:40563	NTIS (US Sales Only), PC A03/MF A01		DE90507354	
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471	15:41405	*See* SSC–156			
477	15:41434	*See* SSC–163			
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511-Rev.	15:41356	*See* SSCL–212-Rev.			
FNAL/C–					
90/125-E	15:41831	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90014387	MF-414
90/126-E	15:41832	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90014386	MF-414
90/127-E	15:41833	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90014385	MF-414
90/65	15:42254	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90011489	MF-400
FRCEA-TH–					
266	15:41765	NTIS (US Sales Only), PC A10/MF A01		DE90508412	
272	15:42153	NTIS (US Sales Only), PC A10/MF A01		DE90508411	
FRNC-TH–					
3576	15:40367	NTIS (US Sales Only), PC A08/MF A01		DE90501036	
FSGTR-RM–					
187	15:41540	*See* PB–90-205477/XAB			
FTINT–					
15-88	15:40982	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90633322	
20-88	15:41283	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90632134	
41-88	15:41042	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90633479	
42-88	15:41284	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90632135	
43-88	15:41265	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90632136	

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
44-88	15:41485	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90632137	
47-88	15:41486	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90632138	
48-88	15:41266	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90632139	
49-88	15:42068	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90631767	
GA-A–					
20057	15:42154	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90013217	MF-426
20058	15:42155	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90014121	MF-421
20076	15:42156	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90014362	MF-420
20081	15:42157	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90014120	MF-420
GKSS–					
89/E/43	15:40983	GKSS-Forschungszentrum Geesthacht GmbH, Geesthacht-Tesperhude (Germany, F.R.)			
89/E/57	15:40740	NTIS (US Sales Only), PC A03/MF A01		DE90510603	
89/E/58	15:40984	NTIS (US Sales Only), PC A03/MF A01		DE90510602	
89/E/6	15:41295	Special print from DVS-Berichte v. 118, 1989, p. 42-47			
89/E/61	15:40985	NTIS (US Sales Only), PC A04/MF A01		DE90510601	
GL-TR–					
89-0096	15:41785	*See* AD-A–220004/6/XAB			
89-0218	15:41774	*See* N–90-20030			
89-0233	15:41792	*See* AD-A–220859/3/XAB			
90-0070	15:41524	*See* AD-A–220833/8/XAB			
GRI–					
86/0326	15:40384	*See* PB–90-216730/XAB			
90/0077	15:40377	*See* PB–90-216763/XAB			
90/0105	15:40373	*See* PB–90-216722/XAB			
90/0126	15:40375	*See* PB–90-219296/XAB			
GRS-A–					
1537	15:40398	*See* BMU–1989-223			
GRS-F–					
179	15:40784	NTIS (US Sales Only), PC A04/MF A01		DE90510253	
GSF–					
2/90	15:41702	NTIS (US Sales Only), PC A05/MF A01		DE90510286	
26/86	15:40409	NTIS (US Sales Only), PC A06/MF A01		DE90510111	
5/89	15:40408	NTIS (US Sales Only), PC A08/MF A01		DE90510114	
GSF-TL–					
3/89	15:40408	*See* GSF–5/89			
GSI–					
90-09	15:42016	NTIS (US Sales Only), PC A03/MF A01		DE90510599	
90-24(prepr.)	15:42017	Gesellschaft fuer Schwerionenforschung mbH, Darmstadt (Germany, F.R.)			
HAN–					
45801	15:40761	NTIS, PC A09/MF A01 - OSTI		DE90014135	MF-700
45830-Del.	15:40762	NTIS, PC A07/MF A01 - OSTI		DE90014133	MF-700
63605-Del.	15:40763	NTIS, PC A06/MF A01 - OSTI		DE90014134	MF-700
HBI-REF–					
89-4222-171	15:40888	*See* PB–90-224619/XAB			
HCA–					
147-88	15:41696	*See* AD-A–220145/7/XAB			
HDL-TR–					
2165	15:41299	*See* AD-A–220066/5/XAB			
HMI-B–					
470	15:41235	NTIS (US Sales Only), PC A03/MF A01		DE90510214	
471	15:41236	NTIS (US Sales Only), PC A03/MF A01		DE90510213	
479	15:40741	NTIS (US Sales Only), PC A03/MF A01		DE90510604	
HW–					
64517	15:41620	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90014018	MF-502
66023	15:40736	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90014019	MF-502
69723	15:41621	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90014023	MF-902
69988-Rev.2	15:40461	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90014024	MF-510
7-6048-Del.	15:40764	NTIS, PC A08/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90014020	MF-700
70937	15:41622	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90014017	MF-502
71718	15:41623	NTIS, PC A02/MF A01 - OSTI		DE90014021	MF-502
IA–					
180/90	15:40477	*See* OEFZS–4537			
IAE–					
4635-12	15:40390	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90633953	

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4704-4	15:40704	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90634089	
4708-6	15:42158	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90631970	
4728-1	15:42018	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90632513	
4777-6	15:42232	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90632041	
4816-2	15:41412	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90634003	
4819-6	15:42159	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90631932	
IAEA-AL–					
028	15:41114	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90632797	
029	15:41115	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90632798	
IAEA-INFCIRC–					
379	15:40470	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90634379	
IAEA-R–					
5545-F	15:41116	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90632799	
IAEA-TECDOC–					
528	15:40674	NTIS (US Sales Only), PC A13/MF A01; OSTI; INIS		DE90634346	
543	15:42255	NTIS (US Sales Only), PC A04/MF A01; OSTI; INIS		DE90634395	
545	15:41685	NTIS (US Sales Only), PC A09/MF A01; OSTI; INIS		DE90633837	
547	15:40603	NTIS (US Sales Only), PC A05/MF A01; OSTI; INIS		DE90634084	
IC–					
89/149	15:42160	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90631971	
89/232	15:41954	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90631639	
89/275	15:42103	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90631579	
89/276	15:42104	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90631580	
89/347	15:42105	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90631590	
89/354	15:41595	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90633601	
89/381	15:41877	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90632208	
89/386	15:42106	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90631619	
89/409	15:41441	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90634024	
89/419	15:42069	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90631768	
90/12	15:42107	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90631581	
90/25	15:42108	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90631582	
90/26	15:42109	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90631620	
90/27	15:41796	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90631713	
90/29	15:42110	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90631583	
90/32	15:42071	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90631769	
90/36	15:41533	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90633625	
90/37	15:42111	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90631584	
90/38	15:41878	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90632373	

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90/43	15:40986	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90633348	
90/49	15:42094	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90632141	
90/51	15:41955	NTIS (US Sales Only), PC A03/MF A01 - OSTI		DE90014257	
90/55	15:42072	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90631764	
90/56	15:42073	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90631765	
90/57	15:41956	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90631641	
90/59	15:41766	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90632060	
90/6	15:42070	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90631766	
90/60	15:41767	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90632061	
90/61	15:42112	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90631591	
90/64	15:42113	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90631585	
90/65	15:42095	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90632142	
90/66	15:42114	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90631586	
90/8	15:42019	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90632603	
ICASE–					
90-25	15:42131	*See* N–90-20650			
90-27	15:42132	*See* N–90-20768			
ICR–					
201-89-18	15:41456	NTIS (US Sales Only), PC A03/MF A01		DE90508085	
IEACR–					
24	15:40322	IEA Coal Research, Gemini House, 10-18 Putney Hill, London SW15 6AA, United Kingdom			
IFSR–					
338	15:42150	*See* DOE/ET/53088–338			
431	15:42151	*See* DOE/ET/53088–431			
IFVE-OEF–					
89-92	15:41457	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90634176	
IFVE-OKU–					
88-112	15:41413	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90633998	
IFVE-OLU–					
89-115	15:41329	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90633973	
IFVE-ONF–					
89-100	15:41458	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90634177	
89-120	15:41834	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90632439	
89-149	15:41459	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90634178	
IFVE-OTF–					
89-89	15:41879	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90632155	
IFVE-OTF-NTL–					
89-141	15:41880	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90632227	
IFVE-OUNK–					
89-108	15:41442	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90634025	
89-125	15:41443	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90634026	
89-159	15:41414	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90634000	
89-164	15:41444	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90634027	
89-174	15:41445	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90634028	

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IFVE-OUNK-OEA–					
89-85	15:41415	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90633999	
IG–					
90/01	15:41596	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90633825	
IKE–					
6-180	15:40688	*See* KFK–4695			
INDC(CPR)–					
017	15:42020	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90632616	
INDC(CUB)–					
002	15:42021	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90632617	
003	15:42055	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90632499	
INDC(EUR)–					
024/G	15:41980	*See* NEANDC(E)–312-U-Vol.3-EURATOM			
INDC(JPN)–					
139/L	15:42009	*See* JAERI-M–90-101			
INP–					
1350/B	15:41597	NTIS (US Sales Only), PC A04/MF A01; OSTI; INIS		DE90633847	
1358/PH	15:41881	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90632283	
1367/PL	15:41882	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90632284	
1370/PL	15:42022	NTIS (US Sales Only), PC A20/MF A01; OSTI; INIS		DE90632511	
1371/PL	15:41460	NTIS (US Sales Only), PC A05/MF A01; OSTI; INIS		DE90634212	
1380/C	15:41242	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90633186	
1384/PL	15:42023	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90632605	
INS–					
804	15:41768	NTIS (US Sales Only), PC A03/MF A01		DE90507990	
807	15:41883	NTIS (US Sales Only), PC A03/MF A01		DE90508023	
809	15:41835	NTIS (US Sales Only), PC A02/MF A01		DE90508027	
810	15:41986	NTIS (US Sales Only), PC A03/MF A01		DE90508025	
INS-T–					
493	15:41884	NTIS (US Sales Only), PC A15/MF A01		DE90508071	
INT–					
208/P	15:42233	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90632021	
209/I	15:41461	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90634213	
210/I	15:41462	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90634147	
215/I	15:40785	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90633865	
IPNO-TH–					
89-12	15:42115	NTIS (US Sales Only), PC A05/MF A01		DE90508324	
8920	15:41950	NTIS (US Sales Only), PC A05/MF A01		DE90508413	
IS-T–					
1466	15:41117	NTIS, PC A07/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90014427	MF-401
1467	15:41118	NTIS, PC A07/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90014428	MF-401
1475	15:40285	NTIS, PC A05/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90014418	MF-401
ISI/RS–					
89-249	15:42262	*See* AD-A–220250/5/XAB			
ISPO–					
317	15:41124	*See* UCRL-LR–103220-Vol.1			
ISWS/RI–					
112/90	15:40374	*See* PB–90-219361/XAB			
ITEF–					
103-89	15:41837	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90632435	
55-89	15:41885	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90632285	
56-89	15:41836	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90632394	

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67-89	15:41886	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90632286	
80-89	15:41887	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90632287	
81-89	15:41888	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90632288	
86-89	15:42074	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90631893	
90-89	15:41889	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90632289	
ITEP–					
105-89	15:41892	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90632290	
106-89	15:41981	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90632725	
111-89	15:41839	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90632471	
62-89	15:41838	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90632472	
65-89	15:41890	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90632291	
94-89	15:41957	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90631650	
97-89	15:41891	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90632292	
ITF–					
87-120	15:41893	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90632293	
87-135	15:41894	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90632294	
87-146	15:42161	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90631988	
87-151	15:42162	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90631972	
87-169	15:42163	NTIS (US Sales Only), PC A04/MF A01; OSTI; INIS		DE90631973	
88-31	15:41895	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90632295	
88-32	15:41896	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90632296	
ITP–					
87-119	15:42024	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90632557	
87-133	15:42025	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90632558	
87-136	15:42026	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90632626	
87-138	15:41958	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90631651	
87-165	15:42027	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90632627	
88-23	15:41897	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90632297	
ITPR–					
90015	15:42116	the Technische Universitaet Graz, Petersgasse 16, A-8010 Graz			
IWGFR–					
70	15:40654	NTIS (US Sales Only), PC A09/MF A01; OSTI; INIS		DE90634121	
71	15:40706	NTIS (US Sales Only), PC A16/MF A01; OSTI; INIS		DE90634050	
IWGGCR–					
20-1	15:40635	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90634103	
20-2	15:40636	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90634104	
IYaF–					
88-149	15:42075	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90631894	
88-160	15:41313	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90634242	

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88-99	15:42164	NTIS (US Sales Only), PC A04/MF A01; OSTI; INIS		DE90631989	
89-2	15:41898	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90632298	
89-3	15:41446	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90634031	
89-4	15:42293	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90634386	
89-5	15:42165	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90631974	
89-15	15:41899	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90632216	
89-16	15:42056	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90632507	
89-33	15:42166	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90631990	
89-36	15:42167	NTIS (US Sales Only), PC A04/MF A01; OSTI; INIS		DE90631991	
89-39	15:41463	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90634214	
89-64	15:41416	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90634001	
89-65	15:42168	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90631992	
89-72	15:42117	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90631596	
89-80	15:42234	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90632044	
IfB-F–					
706	15:40916	Copy held by UB/TIB Hannover			
JA–					
5592	15:41063	*See* AD-A–220229/9/XAB			
6386	15:41303	*See* AD-A–220227/3/XAB			
JAERI-M–					
89-212	15:42060	NTIS (US Sales Only), PC A16/MF A01		DE90508083	
89-215	15:42235	NTIS (US Sales Only), PC A99/MF A01		DE90508029	
90-001	15:42236	NTIS (US Sales Only), PC A03/MF A01		DE90508031	
90-007	15:42294	NTIS (US Sales Only), PC A07/MF A01		DE90508033	
90-010	15:41074	NTIS (US Sales Only), PC A03/MF A01		DE90508070	
90-011	15:41075	NTIS (US Sales Only), PC A04/MF A01		DE90508040	
90-017	15:40742	NTIS (US Sales Only), PC A04/MF A01		DE90508035	
90-019	15:40608	NTIS (US Sales Only), PC A04/MF A01		DE90508050	
90-020	15:40743	NTIS (US Sales Only), PC A04/MF A01		DE90508052	
90-021	15:40744	NTIS (US Sales Only), PC A04/MF A01		DE90508084	
90-022	15:42061	NTIS (US Sales Only), PC A03/MF A01		DE90508042	
90-023	15:40410	NTIS (US Sales Only), PC A03/MF A01		DE90508082	
90-027	15:40765	NTIS (US Sales Only), PC A03/MF A01		DE90508081	
90-028	15:42237	NTIS (US Sales Only), PC A05/MF A01		DE90508064	
90-029	15:40745	NTIS (US Sales Only), PC A03/MF A01		DE90508047	
90-030	15:42008	NTIS (US Sales Only), PC A03/MF A01		DE90508037	
90-032	15:40746	NTIS (US Sales Only), PC A03/MF A01		DE90508066	
90-036	15:40786	NTIS (US Sales Only), PC A07/MF A01		DE90508054	
90-038	15:42238	NTIS (US Sales Only), PC A04/MF A01		DE90508067	
90-039	15:40787	NTIS (US Sales Only), PC A07/MF A01		DE90508065	
90-045	15:42295	NTIS (US Sales Only), PC A08/MF A01		DE90508045	
90-101	15:42009	Japan Atomic Energy Research Institute, Tokai-mura, Naka-gun, Ibaraki-ken 319-11, Japan			
JINR–					
1-34-89	15:41763	NTIS (US Sales Only), PC A05/MF A01; OSTI; INIS		DE90706109	
13-89-279	15:41464	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90634151	
13-89-297	15:41465	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90634152	
13-89-393	15:41502	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90634245	
13-89-445	15:41466	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90634153	
16-89-353	15:42062	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90633891	
18-89-113	15:42057	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90632500	

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
8-89-210	15:41314	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90632140	
9-89-199	15:41417	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90633993	
9-89-300	15:41365	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90633985	
9-89-301	15:41366	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90633986	
9-89-368	15:41418	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90633997	
JINR-D–					
1,2-88-652/v.1	15:41828	NTIS (US Sales Only), PC A20/MF A01; OSTI; INIS		DE90706115	
JINR-E–					
1-89-222	15:41984	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90632728	
1-89-246	15:41985	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90632729	
1-89-252	15:42003	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90632773	
1-89-341	15:41991	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90632745	
1-89-345	15:41854	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90632487	
10-89-302	15:41467	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90634243	
14-89-336	15:42077	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90631774	
14-89-455	15:42096	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90632143	
15-89-44	15:42000	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90632770	
19-89-239	15:41703	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90633693	
2-89-120	15:41962	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90631654	
2-89-13	15:41960	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90631655	
2-89-169	15:41924	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90632321	
2-89-214	15:41419	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90633996	
2-89-233	15:42076	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90631895	
2-89-273	15:42121	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90631597	
2-89-359	15:41963	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90631656	
2-89-392	15:41964	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90631657	
2-89-417	15:41965	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90631658	
2-89-437	15:42036	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90632632	
2-89-58	15:41961	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90631659	
2-89-62	15:41923	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90632322	
2-89-74	15:42120	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90631598	
4-88-906	15:42037	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90632562	
4-89-187	15:42038	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90632563	
4-89-267	15:42039	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90632564	
4-89-275	15:42122	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90631599	
4-89-330	15:42040	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90632688	
4-89-432	15:41925	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90632323	

JINR-E–

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
4-89-443	15:42041	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90632633	
4-89-444	15:42042	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90632634	
6-89-60	15:41999	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90632771	
7-89-238	15:42296	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90634387	
7-89-72	15:41977	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90632707	
JINR-R–					
1-89-112	15:41978	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90632708	
1-89-213	15:41997	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90632760	
1-89-240	15:41992	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90632746	
1-89-247	15:42043	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90632635	
1-89-332	15:41855	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90632488	
10-89-293	15:41468	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90634185	
10-89-319	15:41469	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90634148	
10-89-436	15:42297	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90634381	
10-89-454	15:41503	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90634244	
11-89-191	15:42130	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90631600	
11-89-378	15:42298	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90634388	
11-89-382	15:42299	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90634382	
11-89-383	15:42300	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90634389	
11-89-427	15:42301	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90634390	
13-89-208	15:41470	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90634186	
13-89-209	15:41471	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90634187	
13-89-361	15:41472	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90634188	
13-89-458	15:41473	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90634189	
13-89-459	15:41474	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90634190	
14-89-101	15:41598	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90633602	
14-89-147	15:42097	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90632144	
15-89-116	15:42004	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90632774	
15-89-130	15:41476	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90634149	
15-89-98	15:41475	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90634150	
16-88-531	15:42063	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90633890	
2-89-175	15:42123	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90631621	
2-89-198	15:42124	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90631601	
2-89-234	15:42125	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90631622	
2-89-375	15:41926	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90632324	
2-89-435	15:41966	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90631660	

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
4-89-109	15:42044	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90632565	
4-89-179	15:42045	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90632566	
4-89-287	15:42126	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90631602	
4-89-325	15:42046	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90632567	
4-89-426	15:41797	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90631718	
5-89-159	15:42127	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90631603	
5-89-160	15:42128	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90631604	
5-89-322	15:42129	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90631605	
6-88-911	15:42001	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90632772	
6-89-200	15:42007	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90632780	
6-89-354	15:41243	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90633187	
7-89-346	15:42047	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90632636	
9-89-355	15:41420	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90633992	
Jusi–					
2276	15:41477	NTIS (US Sales Only), PC A06/MF A01		DE90510131	
2330	15:41076	NTIS (US Sales Only), PC A06/MF A01		DE90510258	
2331	15:40647	NTIS (US Sales Only), PC A04/MF A01		DE90510150	
Jusi-Spez–					
498	15:40411	NTIS (US Sales Only), PC A03/MF A01		DE90510116	
522	15:41534	NTIS (US Sales Only), PC A03/MF A01		DE90510165	
K/CSD/INF–					
89/42	15:41244	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90012154	MF-701
90/28	15:40788	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90014316	MF-523
K/WM–					
5	15:40413	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90014320	MF-512
KAPL–					
4714	15:41624	NTIS, PC A06/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90014346	MF-507
KEK–					
89-21	15:41315	NTIS (US Sales Only), PC A99/MF A01		DE90508149	
89-23	15:41798	NTIS (US Sales Only), PC A99/MF A01		DE90508150	
89-26	15:42316	NTIS (US Sales Only), PC A11/MF A01		DE90508151	
KFK–					
4604	15:41535	NTIS (US Sales Only), PC A03/MF A01		DE90510167	
4643	15:40412	NTIS (US Sales Only), PC A07/MF A01		DE90510166	
4695	15:40688	NTIS (US Sales Only), PC A03/MF A01		DE90510275	
4704	15:40987	NTIS (US Sales Only), PC A07/MF A01		DE90510282	
4705	15:40665	NTIS (US Sales Only), PC A04/MF A01		DE90510181	
KFKI–					
1989-56/A	15:42048	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90632638	
1989-57/J	15:41245	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90633153	
1989-59/J	15:41119	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90632801	
1989-60/A	15:41927	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90632162	
1989-61/G	15:40699	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90634038	
1989-62/M	15:42302	NTIS (US Sales Only), PC A12/MF A01; OSTI; INIS		DE90634391	
1989-64/B	15:41769	NTIS (US Sales Only), PC A04/MF A01; OSTI; INIS		DE90632119	
1989-65/A	15:42049	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90632570	
1989-66/G	15:40729	NTIS (US Sales Only), PC A07/MF A01; OSTI; INIS		DE90634073	
1989-67/A	15:41928	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90632327	

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1989-69/G	15:41285	NTIS (US Sales Only), PC A04/MF A01; OSTI; INIS		DE90633965	
1989-70/G	15:40789	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90634090	
1990-01/C	15:41770	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90632062	
1990-03/A	15:42050	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90632607	
1990-04/A	15:41929	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90632328	
1990-06/A	15:41930	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90632329	
1990-07/A	15:41856	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90632489	
1990-08/G	15:40790	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90634039	
1990-09/A	15:41931	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90632330	
KFTI–					
88-15	15:42169	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90631964	
88-18	15:42170	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90631959	
KIYI–					
88-34	15:41799	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90631747	
88-42	15:40730	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90634074	
88-43	15:40731	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90634075	
KU-HCOE-FL2-R–					
90-1	15:42079	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90631896	
90-2	15:42080	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90631897	
90-3	15:42081	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90631775	
90-4	15:42082	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90631898	
90-5	15:42083	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90631899	
KY/H–					
104-Rev.1	15:40414	NTIS, PC A04/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90014392	MF-630
L–					
16719	15:40475	*See* N–90-18882			
16738	15:41705	*See* N–90-21715			
LA–					
11415-MS	15:40791	NTIS, PC A99/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90014435	
11795-MS	15:41599	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90013623	MF-902
11827-MS	15:40395	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90013531	MF-700
11865-PR	15:41246	NTIS, PC A06/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90013607	MF-601; MF-901
11896-MS	15:40392	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90014409	MF-731; MF-701
11902-MS	15:42303	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90014417	
LA-UR–					
90-1386	15:41536	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010612	
90-1514	15:40358	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90012100	MF-122
90-1762	15:41127	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90012063	MF-704
90-1848	15:41316	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90012155	MF-906
90-1959	15:41128	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90013183	MF-901; MF-905
90-1963	15:40766	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90013179	MF-731
90-2000	15:41120	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90013174	MF-731
90-2043	15:41509	NTIS, PC A02/MF A01 - OSTI		DE90013692	
90-2092	15:41800	NTIS, PC A03/MF A01 - OSTI		DE90013161	
90-355	15:41704	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90006514	MF-408
90-827	15:40988	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90009002	MF-706
LBL–					
26899	15:40568	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90014190	MF-253
28019	15:40892	NTIS, PC A04/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90013361	MF-350

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
28273	15:40917	NTIS, PC A04/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90013360	MF-350
28428	15:40415	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90014307	MF-814
28429	15:40416	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90014037	MF-814
28430	15:40417	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90014308	MF-814
28526	15:42084	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90013359	MF-411
28529	15:42239	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90014180	MF-414
28566	15:42317	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90014165	MF-405
28618-1/3	15:40566	NTIS, PC A06/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90014001	MF-252
28618-2/3	15:40569	NTIS, PC A11/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90013808	MF-252
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89-24	15:41451	*See* CEA-DPHPE–89-17			
89-28	15:41479	NTIS (US Sales Only), PC A02/MF A01		DE90508323	
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415	15:42258	*See* AD-A–219843/0/XAB			
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90-1	15:41062	*See* AD-A–220209/1/XAB			

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0964-8300	15:40376	*See* PB–90-216573/XAB			
90-18882	15:40475	NTIS, PC A03/MF A01			
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90-19940	15:41773	NTIS, PC A11/MF A02			
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90-20918	15:41776	NTIS, PC A03/MF A01			
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90-21123	15:40994	NTIS, PC A03/MF A01			
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90-21715	15:41705	NTIS, PC A03/MF A01			
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NAC–					
88-17	15:41423	the National Accelerator Centre, Council for Scientific and Industrial Research, P.O. Box 72, Faure, 7131, South Africa			
NAC-T–					
89009-Vol.1	15:41262	*See* DOE/ID/12702–1-Vol.1			
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NAGRA-NTB–					
86-11	15:40418	Nagra, CH-5401 Baden, Switzerland			
NAS–					
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1.15:102571	15:41082	*See* N–90-20886			

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3046	15:41773	*See* N–90-19940			
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312-U-Vol.3-EURATOM	15:41980	Office for Official Publications of the European Communities, 2, rue Mercier, L-2985 Luxembourg			

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NOAA-TM-ERL-CMDL–					
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89-167	15:41731	*See* PB–90-216896/XAB			
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OEFZS-A–					
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10914	15:41537	NTIS, PC A04/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90014699	MF-402
11200	15:40732	*See* NUREG/CR–5374			
11283	15:40420	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90014203	MF-510
11434	15:40421	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90014701	MF-512
11491	15:42305	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90014697	MF-405
11512	15:42306	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90014709	MF-405
11537	15:42256	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90014700	MF-406
11550	15:41679	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90013608	MF-408
11563	15:42307	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90013626	MF-405
ORNL/tr–					
90/9	15:41290	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90011528	MF-406; MF-401
OTA-BP-O–					
63	15:40364	*See* PB–90-219973/XAB			
OULNS–					
89-11	15:41456	*See* ICR–201-89-18			
OUT–					
1642	15:40767	NTIS, PC A02/MF A01 - OSTI		DE90014202	MF-731
1651	15:40768	NTIS, PC A02/MF A01 - OSTI		DE90013021	MF-731
PATENTS-USA–					
Application7-371,782	15:40368	NTISPC N03/MF A01			
Application7-490,898	15:40454	NTISPC N03/MF A01			
Application7-502,709	15:41110	NTISPC N03/MF A01			
Application7-352,325	15:42101	NTISPC N03/MF A01			
PB–					
90-187949/XAB	15:41538	NTIS, PC A17/MF A02			
90-192774/XAB	15:41722	NTIS, PC A03/MF A01			
90-195587/XAB	15:41539	NTIS, PC A99/MF A04			

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90-203746/XAB	15:41318	NTIS, PC A06/MF A01			
90-203753/XAB	15:41319	NTIS, PC A06/MF A01			
90-203845/XAB	15:41047	NTIS, PC A05/MF A01			
90-205477/XAB	15:41540	NTIS, PC A03/MF A01			
90-206228/XAB	15:40925	NTIS, PC A07/MF A01			
90-206459/XAB	15:40964	NTIS, PC A03/MF A01			
90-206483/XAB	15:40926	NTIS, PC A08/MF A01			
90-207242/XAB	15:41541	NTIS, PC A11/MF A02			
90-207325/XAB	15:40927	NTIS, PC A10/MF A02			
90-207374/XAB	15:40928	NTIS, PC A11/MF A02			
90-207663/XAB	15:41123	NTIS, PC A08/MF A01			
90-207978/XAB	15:41542	NTIS, PC A03/MF A01			
90-208299/XAB	15:40929	NTIS, PC A07/MF A01			
90-208331/XAB	15:41626	NTIS, PC A03/MF A01			
90-208349/XAB	15:41602	NTIS, PC A03/MF A01			
90-208356/XAB	15:41627	NTIS, PC A02/MF A01			
90-208372/XAB	15:41628	NTIS, PC A03/MF A01			
90-208380/XAB	15:41629	NTIS, PC A03/MF A01			
90-208398/XAB	15:41630	NTIS, PC A03/MF A01			
90-208570/XAB	15:41543	NTIS, PC A03/MF A01			
90-208588/XAB	15:41544	NTIS, PC A05/MF A01			
90-208992/XAB	15:40329	NTIS, PC A08/MF A01			
90-209313/XAB	15:40930	NTIS, PC A05/MF A01			
90-209321/XAB	15:40931	NTIS, PC A04/MF A01			
90-209891/XAB	15:40331	NTIS, PC A04/MF A01			
90-210014/XAB	15:40330	NTIS, PC A05/MF A01			
90-210477/XAB	15:40918	NTIS, PC A05/MF A01			
90-210998/XAB	15:40871	NTIS, PC A11/MF A02			
90-211004/XAB	15:40872	NTIS, PC A11/MF A02			
90-211418/XAB	15:40567	NTIS, PC A21/MF A03			
90-211665/XAB	15:41723	NTIS, PC A06/MF A01			
90-212093/XAB	15:40873	NTIS, PC A06/MF A01			
90-212200/XAB	15:41545	NTIS, PC A20/MF A03			
90-212549/XAB	15:41631	NTIS, PC A09/MF A01			
90-212564/XAB	15:41603	NTIS, PC A09/MF A01			
90-212572/XAB	15:41546	NTIS, PC A07/MF A01			
90-212614/XAB	15:41547	NTIS, PC A05/MF A01			
90-212713/XAB	15:41048	NTIS, PC A07/MF A01			
90-212747/XAB	15:41049	NTIS, PC A07/MF A01			
90-212770/XAB	15:40998	NTIS, PC A05/MF A01			
90-213612/XAB	15:40365	NTIS, PC A08/MF A01			
90-213638/XAB	15:40919	NTIS, PC A04/MF A01			
90-213737/XAB	15:41670	NTIS, PC A03/MF A01			
90-214354/XAB	15:40874	NTIS, PC A06/MF A01			
90-215815/XAB	15:42318	NTIS, PC A03/MF A01			
90-215914/XAB	15:41724	NTIS, PC A02/MF A01			
90-215971/XAB	15:40351	NTIS, PC A02/MF A01			
90-216003/XAB	15:41725	NTIS, PC A03/MF A01			
90-216011/XAB	15:41706	NTIS, PC A01/MF A01			
90-216078/XAB	15:41548	NTIS, PC A02/MF A01			
90-216086/XAB	15:41549	NTIS, PC A03/MF A01			
90-216094/XAB	15:41550	NTIS, PC A03/MF A01			
90-216102/XAB	15:41551	NTIS, PC A03/MF A01			
90-216110/XAB	15:41726	NTIS, PC A02/MF A01			
90-216144/XAB	15:41727	NTIS, PC A03/MF A01			
90-216243/XAB	15:41728	NTIS, PC A03/MF A01			
90-216268/XAB	15:41604	NTIS, PC A02/MF A01			
90-216276/XAB	15:41632	NTIS, PC A03/MF A01			
90-216284/XAB	15:41633	NTIS, PC A03/MF A01			
90-216300/XAB	15:41634	NTIS, PC A02/MF A01			
90-216342/XAB	15:41552	NTIS, PC A03/MF A01			
90-216359/XAB	15:41729	NTIS, PC A03/MF A01			
90-216375/XAB	15:41730	NTIS, PC A03/MF A01			
90-216383/XAB	15:41635	NTIS, PC A03/MF A01			
90-216409/XAB	15:41553	NTIS, PC A02/MF A01			
90-216433/XAB	15:41554	NTIS, PC A06/MF A01			
90-216441/XAB	15:40598	NTIS, PC A04/MF A01			
90-216458/XAB	15:41636	NTIS, PC A08/MF A01			
90-216466/XAB	15:40363	NTIS, PC A03/MF A01			
90-216516/XAB	15:40875	NTIS, PC A05/MF A01			
90-216524/XAB	15:41637	NTIS, PC A05/MF A01			

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90-216532/XAB	15:41555	NTIS, PC A06/MF A01			
90-216573/XAB	15:40376	NTIS, PC A04/MF A01			
90-216623/XAB	15:40369	NTIS, PC A05/MF A01			
90-216631/XAB	15:40371	NTIS, PC A10/MF A02			
90-216698/XAB	15:40383	NTIS, PC A04/MF A01			
90-216706/XAB	15:40332	NTIS, PC A04/MF A01			
90-216722/XAB	15:40373	NTIS, PC A04/MF A01			
90-216730/XAB	15:40384	NTIS, PC A02/MF A01			
90-216748/XAB	15:40932	NTIS, PC A03/MF A01			
90-216755/XAB	15:40372	NTIS, PC A08/MF A01			
90-216763/XAB	15:40377	NTIS, PC A09/MF A02			
90-216896/XAB	15:41731	NTIS, PC A12/MF A02			
90-216904/XAB	15:41732	NTIS, PC A16/MF A02			
90-216995/XAB	15:41605	NTIS, PC A04/MF A01			
90-217084/XAB	15:41556	NTIS, PC A04/MF A01			
90-217191/XAB	15:41638	NTIS, PC A03/MF A01			
90-217217/XAB	15:41639	NTIS, PC A03/MF A01			
90-217316/XAB	15:41733	NTIS, PC A09/MF A01			
90-217332/XAB	15:40378	NTIS, PC A03/MF A01			
90-217340/XAB	15:40379	NTIS, PC A14/MF A02			
90-217381/XAB	15:41640	NTIS, PC A03/MF A01			
90-217423/XAB	15:41734	NTIS, PC A03/MF A01			
90-217506/XAB	15:40352	NTIS, PC A02/MF A01			
90-217555/XAB	15:41748	NTIS, PC A02/MF A01			
90-217563/XAB	15:41735	NTIS, PC A03/MF A01			
90-217621/XAB	15:41641	NTIS, PC A02/MF A01			
90-217654/XAB	15:41736	NTIS, PC A02/MF A01			
90-218611/XAB	15:41557	NTIS, PC A07/MF A01			
90-219049/XAB	15:41642	NTIS, PC A15/MF A02			
90-219064/XAB	15:41643	NTIS, PC A99/MF A04			
90-219072/XAB	15:41644	NTIS, PC A12/MF A02			
90-219163/XAB	15:41558	NTIS, PC A04/MF A01			
90-219296/XAB	15:40375	NTIS, PC A02/MF A01			
90-219320/XAB	15:41645	NTIS, PC A05/MF A01			
90-219338/XAB	15:41606	NTIS, PC A03/MF A01			
90-219346/XAB	15:41737	NTIS, PC A03/MF A01			
90-219361/XAB	15:40374	NTIS, PC A03/MF A01			
90-219379/XAB	15:41607	NTIS, PC A03/MF A01			
90-219395/XAB	15:41646	NTIS, PC A11/MF A02			
90-219585/XAB	15:40945	NTIS, PC A06/MF A01			
90-219601/XAB	15:40380	NTIS, PC A16/MF A02			
90-219619/XAB	15:41269	NTIS, PC A05/MF A01			
90-219650/XAB	15:41647	NTIS, PC A03/MF A01			
90-219676/XAB	15:41738	NTIS, PC A02/MF A01			
90-219726/XAB	15:41559	NTIS, PC A02/MF A01			
90-219759/XAB	15:41560	NTIS, PC A02/MF A01			
90-219882/XAB	15:40933	NTIS, PC A20/MF A03			
90-219973/XAB	15:40364	NTIS, PC A05/MF A01			
90-220211/XAB	15:41561	NTIS, PC A06/MF A01			
90-220229/XAB	15:41562	NTIS, PC A09/MF A01			
90-220468/XAB	15:41739	NTIS, PC A05/MF A01			
90-220518/XAB	15:41608	NTIS, PC A02/MF A01			
90-220526/XAB	15:41648	NTIS, PC A09/MF A01			
90-220534/XAB	15:41649	NTIS, PC A19/MF A03			
90-220542/XAB	15:41609	NTIS, PC A08/MF A01			
90-220559/XAB	15:40955	NTIS, PC A04/MF A01			
90-220633/XAB	15:41650	NTIS, PC A11/MF A02			
90-220641/XAB	15:41651	NTIS, PC A04/MF A01			
90-220658/XAB	15:41652	NTIS, PC A15/MF A02			
90-220708/XAB	15:41088	NTIS, PC A03/MF A01			
90-220724/XAB	15:40323	NTIS, PC A03/MF A01			
90-220815/XAB	15:40599	NTIS, PC A03/MF A01			
90-220823/XAB	15:40920	NTIS, PC A03/MF A01			
90-220831/XAB	15:41563	NTIS, PC A03/MF A01			
90-220906/XAB	15:41291	NTIS, PC A06/MF A01			
90-221961/XAB	15:41564	NTIS, PC A02/MF A01			
90-222209/XAB	15:40311	NTIS, PC A03/MF A01			
90-222290/XAB	15:40333	NTIS, PC A03/MF A01			
90-222449/XAB	15:40334	NTIS, PC A04/MF A01			
90-222456/XAB	15:40381	NTIS, PC A03/MF A01			
90-222464/XAB	15:40353	NTIS, PC A03/MF A01			

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90-222522/XAB	15:40956	NTIS, PC A07/MF A01			
90-223678/XAB	15:41565	NTISMF A01			
90-223751/XAB	15:41566	NTIS, PC A12/MF A02			
90-224619/XAB	15:40888	NTIS, PC A08/MF A01			
90-225582/XAB	15:41653	NTIS, PC A03/MF A01			
90-225871/XAB	15:40335	NTIS, PC A03/MF A01			
90-225954/XAB	15:41740	NTIS, PC A03/MF A01			
90-228222/XAB	15:40495	NTIS, PC A04/MF A01			
90-229261/XAB	15:41654	NTIS, PC A04/MF A01			
90-502022/XAB	15:41567	NTISCP D02			
90-502097/XAB	15:41568	NTISCP T03			
90-502238/XAB	15:41671	NTISCP D01			
90-591200/XAB	15:40893	NTISStanding Order			
90-591300/XAB	15:40936	NTISSubscription			
90-868399/XAB	15:40500	NTISPC N01/MF N01			
90-868449/XAB	15:40937	NTISPC N01/MF N01			
90-868456/XAB	15:40948	NTISPC N01/MF N01			
90-868654/XAB	15:40471	NTISPC N01/MF N01			
90-868662/XAB	15:40472	NTISPC N01/MF N01			
90-868696/XAB	15:40385	NTISPC N01/MF N01			
90-868704/XAB	15:40386	NTISPC N01/MF N01			
90-868753/XAB	15:41089	NTISPC N01/MF N01			
90-868761/XAB	15:41779	NTISPC N01/MF N01			
90-868795/XAB	15:41090	NTISPC N01/MF N01			
90-868845/XAB	15:42085	NTISPC N01/MF N01			
90-868951/XAB	15:40457	NTISPC N01/MF N01			
90-868969/XAB	15:40458	NTISPC N01/MF N01			
90-869009/XAB	15:41655	NTISPC N01/MF N01			
90-869017/XAB	15:41656	NTISPC N01/MF N01			
90-869033/XAB	15:41569	NTISPC N01/MF N01			
90-869058/XAB	15:40501	NTISPC N01/MF N01			
90-869124/XAB	15:41657	NTISPC N01/MF N01			
90-869181/XAB	15:40366	NTISPC N01/MF N01			
90-869348/XAB	15:40999	NTISPC N01/MF N01			
90-869389/XAB	15:41320	NTISPC N01/MF N01			
90-869413/XAB	15:41000	NTISPC N01/MF N01			
90-869447/XAB	15:41741	NTISPC N01/MF N01			
90-869504/XAB	15:40938	NTISPC N01/MF N01			
90-869520/XAB	15:40502	NTISPC N01/MF N01			
90-869777/XAB	15:40388	NTISPC N01/MF N01			
90-869785/XAB	15:40389	NTISPC N01/MF N01			
90-869793/XAB	15:40965	NTISPC N01/MF N01			
90-869801/XAB	15:40966	NTISPC N01/MF N01			
90-870023/XAB	15:41570	NTISPC N01/MF N01			
90-870098/XAB	15:41749	NTISPC N01/MF N01			
90-870114/XAB	15:41742	NTISPC N01/MF N01			
90-870130/XAB	15:41680	NTISPC N01/MF N01			
90-870148/XAB	15:40486	NTISPC N01/MF N01			
90-870189/XAB	15:40312	NTISPC N01/MF N01			
90-870270/XAB	15:41743	NTISPC N01/MF N01			
90-870353/XAB	15:40952	NTISPC N01/MF N01			
90-870411/XAB	15:41658	NTISPC N01/MF N01			
90-870536/XAB	15:41571	NTISPC N01/MF N01			
90-870585/XAB	15:42098	NTISPC N01/MF N01			
90-870593/XAB	15:42099	NTISPC N01/MF N01			
90-870601/XAB	15:41681	NTISPC N01/MF N01			
90-870619/XAB	15:41682	NTISPC N01/MF N01			
90-870643/XAB	15:40863	NTISPC N01/MF N01			
90-870734/XAB	15:40324	NTISPC N01/MF N01			
90-870791/XAB	15:41744	NTISPC N01/MF N01			
90-870874/XAB	15:41672	NTISPC N01/MF N01			
90-871005/XAB	15:40949	NTISPC N01/MF N01			
90-871179/XAB	15:40921	NTISPC N01/MF N01			
90-871278/XAB	15:40354	NTISPC N01/MF N01			
90-871286/XAB	15:40355	NTISPC N01/MF N01			
90-871385/XAB	15:41572	NTISPC N01/MF N01			
90-871393/XAB	15:41745	NTISPC N01/MF N01			
90-871450/XAB	15:40950	NTISPC N01/MF N01			
90-871484/XAB	15:40503	NTISPC N01/MF N01			
90-871641/XAB	15:40480	NTISPC N01/MF N01			
90-871658/XAB	15:41573	NTISPC N01/MF N01			

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90-871708/XAB	15:41574	NTISPC N01/MF N01			
90-871724/XAB	15:41659	NTISPC N01/MF N01			
90-871732/XAB	15:41746	NTISPC N01/MF N01			
90-871831/XAB	15:40957	NTISPC N01/MF N01			
90-871906/XAB	15:41660	NTISPC N01/MF N01			
90-871997/XAB	15:40939	NTISPC N01/MF N01			
90-872037/XAB	15:40864	NTISPC N01/MF N01			
90-872367/XAB	15:41091	NTISPC N01/MF N01			
PNC-TN–					
8410-90-001	15:40395	*See* LA–11827-MS			
PNL–					
3594-Rev.10	15:40687	NTIS, PC A13/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90014702	MF-721
6198-Rev.1	15:41707	NTIS, PC A09/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90014333	MF-607
6450-32-HEDR	15:41575	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90014297	MF-707
6791	15:40422	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90013375	MF-403
7237	15:40894	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90013373	MF-310
7357	15:40583	NTIS, PC A04/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90013625	MF-261
7374	15:40423	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90013374	MF-903
7394	15:40424	NTIS, PC A11/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90013635	MF-721
7410-HEDR	15:41708	NTIS, PC A05/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90014617	MF-707
7412-HEDR	15:41709	NTIS, PC A12/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90014616	MF-707
POLY-WRI–					
1573-90	15:41306	*See* AD-A–220290/1/XAB			
PPPL–					
2696	15:42193	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90013620	PC-426
2698	15:42194	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90014714	PC-420; PC-426
2702	15:42244	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90014715	PC-427
2705	15:42245	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90014713	PC-420; PC-426; PC-427
2709	15:42195	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90013621	PC-427
2710	15:42196	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90014712	PC-420
2714	15:42197	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90014733	PC-426
PSI–					
1024/TR-1010-Pt.1	15:40344	*See* DOE/PC/90751–T4-Pt.1			
1024/TR-1010-Pt.2	15:40345	*See* DOE/PC/90751–T4-Pt.2			
PWA–					
3/90	15:40987	*See* KFK–4704			
56/89	15:40412	*See* KFK–4643			
RAND/N–					
2706	15:40878	*See* AD-A–220305/7/XAB			
2842-FF/RC	15:40961	*See* AD-A–220311/5/XAB			
3005-DAG/USDP	15:41506	*See* AD-A–220741/3/XAB			
RAND/R–					
3618	15:40877	*See* AD-A–220301/6/XAB			
3771-AFMIC	15:40963	*See* AD-A–220598/7/XAB			
REG/G–					
3.66	15:40803	NTIS, PC A06/MF A01 - GPO; OSTI; INIS		TI90014383	
REPT–					
270	15:40567	*See* PB–90-211418/XAB			
90B00019	15:41772	*See* N–90-18957			
RERF-CR–					
1-89	15:41710	NTIS (US Sales Only), PC A03/MF A01		DE90508015	
2-89	15:41711	NTIS (US Sales Only), PC A03/MF A01		DE90508013	
RERF-TR–					
10-89	15:41713	NTIS (US Sales Only), PC A03/MF A01		DE90508011	
15-89	15:41714	NTIS (US Sales Only), PC A03/MF A01		DE90508005	
16-89	15:41715	NTIS (US Sales Only), PC A02/MF A01		DE90508009	
6-89	15:41712	NTIS (US Sales Only), PC A03/MF A01		DE90508007	
RI–					
211	15:41995	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90632756	
RISC-M–					
2846	15:42086	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90631776	
SAIC–					
89/1744	15:40794	*See* NUREG/CR–5510			
SAND–					
89-0874C	15:41270	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89013932	MF-261; MF-262

SAND–

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
89-1368	15:41661	NTIS, PC A11/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90013799	MF-630
89-1538	15:42246	NTIS, PC A04/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90013642	MF-712
89-1748	15:40865	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90013873	MF-210
89-2101-Vol.1	15:40804	NTIS, PC A14/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90014707	MF-610
89-2101-Vol.2	15:40805	NTIS, PC A99/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90014703	MF-610
89-2211	15:42058	NTIS, PC A08/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90014748	MF-505
89-2345	15:41001	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90013643	MF-904
89-2369	15:40793	*See* NUREG/CP–5461			
89-2964	15:40560	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90013609	MF-235
89-3103	15:40425	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90013644	MF-706
89-7056	15:40426	NTIS, PC A99/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90014708	MF-810
89-7064	15:41271	NTIS, PC A06/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90013631	MF-700
90-0016C	15:41002	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90013309	MF-704
90-0047C	15:42308	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90013366	MF-705
90-0078	15:40934	NTIS, PC A06/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90014750	MF-705
90-0115C	15:40806	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90012225	MF-700
90-0228	15:40427	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90013629	MF-721
90-0518	15:41496	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90013630	MF-706
90-0572	15:40970	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90013610	MF-515
90-0589	15:42309	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90014742	MF-410
90-0592C	15:42319	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90013496	MF-705
90-0666C	15:41272	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90013369	MF-700
90-0668C	15:40463	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90013367	MF-700
90-0669C	15:41273	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90013874	MF-700
90-0683	15:40370	NTIS, PC A05/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90013600	MF-132
90-0694	15:41511	NTIS, PC A06/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90013611	MF-607
90-0723C	15:40464	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90013838	MF-700
90-0754C	15:42310	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90013368	MF-700
90-0764C	15:41274	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90013363	MF-706
90-0767C	15:40393	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90013839	MF-732; MF-706
90-0768C	15:41497	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90013865	MF-706
90-0770C	15:40465	NTIS, PC A02/MF A01; OSTI; INIS		DE90013841	MF-722
90-0771C	15:41275	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90013364	MF-705
90-0772C	15:40466	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90013354	MF-700
90-0774C	15:40467	NTIS, PC A02/MF A01 - OSTI; GPO Dep	E 1.99:	DE90013807	MF-700
90-0807	15:40468	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90013510	MF-515
90-0950	15:41092	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90013612	MF-404
90-0951	15:41093	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90013613	MF-404
90-1185	15:41276	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90014746	MF-405
90-1247C	15:41277	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90014368	MF-704
90-1266	15:42133	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90014744	MF-705
90-1359	15:41321	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90013616	MF-706
90-1464	15:41806	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90014749	MF-427
90-1573C	15:42100	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90013365	MF-411; MF-406
90-1681	15:42311	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90014704	MF-905
90-1767C	15:40504	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90013843	MF-274
90-1795C	15:41576	NTIS, PC A02/MF A01 - OSTI		DE90013372	MF-700
90-1829C	15:40866	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90014329	MF-212
90-1841C	15:42247	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90014327	MF-712
90-1938C	15:41332	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90014567	MF-706
90-7029	15:40505	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90013628	MF-274
SBI-R–					
208	15:40922	Statens Byggeforskningsinstitut, Postboks 119, DK-2970 Hoersholm, Denmark. DKK.91			
SCIENTIFIC–					
1	15:41586	*See* AD-A–220771/0/XAB			
2	15:41787	*See* AD-A–220105/1/XAB			
SERI/TP–					
211-3679	15:40556	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90000321	MF-270
211-3830	15:40557	NTIS, PC A04/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90000342	MF-274
SIEMENS-KWU-U9–					
414/87/030	15:40807	Copy held by UB/TIB Hannover			
414/89/001	15:40808	Copy held by UB/TIB Hannover			
SLAC-PUB–					
3870	15:41345	*See* SSC–55			
5085	15:41933	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90008013	MF-414
5217	15:41424	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90013640	MF-414
5220	15:41368	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90013569	MF-414
5257	15:41425	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90013639	MF-414

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
SOL–					
90-1	15:42260	*See* AD-A–219850/5/XAB			
90-2	15:42259	*See* AD-A–219849/7/XAB			
90-9	15:42312	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90014406	MF-405
SPIRE-QR–					
10120-03	15:40497	*See* AD-A–220500/3/XAB			
SSC–					
2	15:41333	NTIS, PC A07/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90014005	MF-414
3	15:41334	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90014112	MF-414
5	15:41335	NTIS, PC A04/MF A01; OSTI; INIS		DE90014113	MF-414
6	15:41369	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90014004	MF-414
7	15:41370	NTIS, PC A07/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90014115	MF-414
8	15:41371	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90014003	MF-414
9	15:41372	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90013997	MF-414
102	15:41428	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90014044	MF-414
107	15:41429	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90014039	MF-414
109	15:41401	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90014040	MF-414
11	15:41426	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90014096	MF-414
110	15:41350	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90014041	MF-414
111	15:41402	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90014043	MF-414
112	15:41430	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90014111	MF-414
126	15:41431	NTIS, PC A07/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90014038	MF-414
127	15:41432	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90014008	MF-414
132	15:41403	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90014443	MF-414
136	15:41351	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90014658	MF-414
139	15:41433	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90015096	MF-414
14	15:41373	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90014106	MF-414
144	15:41404	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90014459	MF-414
146	15:41352	NTIS, PC A06/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90014554	MF-414
147	15:41353	NTIS, PC A03/MF A01; OSTI; INIS		DE90014654	MF-414
15	15:41336	NTIS, PC A04/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90014108	MF-414
150	15:41864	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90014652	MF-414
154	15:41934	NTIS, PC A05/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90013776	MF-414
156	15:41405	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90013788	MF-414
16	15:41374	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90014107	MF-414
163	15:41434	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90013786	MF-414
164	15:41354	NTIS, PC A04/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90014651	MF-414
172	15:41406	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90013789	MF-414
180	15:41435	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90013784	MF-414
183	15:41407	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90014653	MF-414
19	15:41337	NTIS, PC A02/MF A01; OSTI; INIS		DE90014109	MF-414
192	15:41355	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90013780	MF-414
195	15:41436	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90014650	MF-414
20	15:41375	NTIS, PC A02/MF A01; OSTI; INIS		DE90014110	MF-414
202	15:41484	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90014649	MF-414
21	15:41376	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90014089	MF-414
22	15:41377	NTIS, PC A02/MF A01; OSTI; INIS		DE90014105	MF-414
223	15:41437	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90013758	MF-414
23	15:41378	NTIS, PC A02/MF A01; OSTI; INIS		DE90014087	MF-414
230	15:41408	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90013783	MF-414
24	15:41379	NTIS, PC A02/MF A01; OSTI; INIS		DE90014104	MF-414
25	15:41380	NTIS, PC A02/MF A01; OSTI; INIS		DE90013998	MF-414
26	15:41381	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90014092	MF-414
27	15:41338	NTIS, PC A03/MF A01; OSTI; INIS		DE90014086	MF-414
28	15:41382	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90014085	MF-414
29	15:41448	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90014084	MF-414
30	15:41383	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90014083	MF-414
31	15:41339	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90014088	MF-414
32	15:41384	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90014102	MF-414
33	15:41340	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90014103	MF-414
34	15:41341	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90014094	MF-414
35	15:41342	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90014090	MF-414
36	15:41449	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90014093	MF-414
38	15:41385	NTIS, PC A03/MF A01; OSTI; INIS		DE90014042	MF-414
40	15:41386	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90014098	MF-414
41	15:41387	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90014101	MF-414
45	15:41450	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90014091	MF-414
48	15:41388	NTIS, PC A03/MF A01; OSTI; INIS		DE90014009	MF-414
49	15:41343	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90014010	MF-414
51	15:41389	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90014011	MF-414
52	15:41390	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90014095	MF-414

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
SSC–					
54	15:41344	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90014002	MF-414
55	15:41345	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90014000	MF-414
57	15:41391	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90013999	MF-414
62	15:41392	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90014444	MF-414
72	15:41393	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90014433	MF-414
75	15:41394	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90014426	MF-414
76	15:41427	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90014655	MF-414
80	15:41395	NTIS, PC A02/MF A01; OSTI; INIS		DE90014656	MF-414
81	15:41346	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90014657	MF-414
83	15:41347	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90014236	MF-414
85	15:41348	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90014241	MF-414
86	15:41396	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90014006	MF-414
88	15:41397	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90014114	MF-414
93	15:41398	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90014007	MF-414
94	15:41399	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90014099	MF-414
95	15:41400	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90014100	MF-414
98	15:41349	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90014045	MF-414
SSC-N–					
525	15:41406	*See* SSC–172			
SSCL–					
212-Rev.	15:41356	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90014648	MF-414
255	15:41438	NTIS, PC A03/MF A01; OSTI; INIS		DE90013768	MF-414
SSDC–					
37	15:41751	*See* DOE–76-45/37			
ST–					
177/90	15:42064	*See* OEFZS-A–1629			
SULDP–					
1990-1	15:41935	*See* UWThPh–1990-3			
TNO-IGMB-I–					
89-414	15:40940	NTIS (US Sales Only), PC A03/MF A01		DE90797096	
TPR-NS–					
31-No.2	15:40809	GPO; $8.50			MF-607
TR–					
0086(6920-03)-2	15:42263	*See* AD-A–220302/4/XAB			
0088(3940-06)-9	15:41789	*See* AD-A–220376/8/XAB			
0088(3945-01)-1	15:40496	*See* AD-A–220414/7/XAB			
0089(4940-06)-2	15:41788	*See* AD-A–220137/4/XAB			
0089(4940-06)-5	15:41784	*See* AD-A–219981/8/XAB			
0090(5017-03)-1	15:40962	*See* AD-A–220492/3/XAB			
1	15:40840	*See* AD-A–219822/4/XAB			
2	15:40841	*See* AD-A–219823/2/XAB			
6	15:41060	*See* AD-A–220142/4/XAB			
8	15:41061	*See* AD-A–220160/6/XAB			
TRB/NCTRP/SYN–					
14	15:40932	*See* PB–90-216748/XAB			
TTI–					
2-10-85-484-11	15:40931	*See* PB–90-209321/XAB			
2-10-88-1131-2	15:40930	*See* PB–90-209313/XAB			
UBA-FB–					
89-115	15:41662	Copy held by UB/TIB Hannover			
UCID–					
19227-89	15:40350	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90014721	MF-121; MF-131
20824-Add.1	15:41130	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90014725	MF-705
20839-87-4	15:41094	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90014731	MF-704
UCRL–					
100330	15:41322	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008899	MF-706
102303	15:41816	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90013292	MF-700
102304	15:41817	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90013293	MF-700
102516	15:41323	NTIS, PC A02/MF A01 - OSTI		DE90013290	MF-706; MF-741
102750	15:41493	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90011500	MF-706
102751	15:41494	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90011504	MF-700
102791	15:42313	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008786	MF-405
UCRL-ID–					
103911	15:41003	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90014732	MF-504
104183	15:42134	NTIS, PC A16/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90014729	MF-705
104253	15:42135	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90014723	MF-700
UCRL-JC–					
103218	15:41512	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90013486	MF-741
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103593	15:40951	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010875	MF-361
103661	15:41754	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90011229	MF-402
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1990-4	15:42137	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90631610	
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1990-12	15:41937	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90632387	
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0173	15:40434	NTIS, PC A04/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90014339	MF-814
0182-23	15:40435	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90013647	MF-900
0223	15:40436	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90013646	MF-721
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TW Taiwan
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